

Figure 1

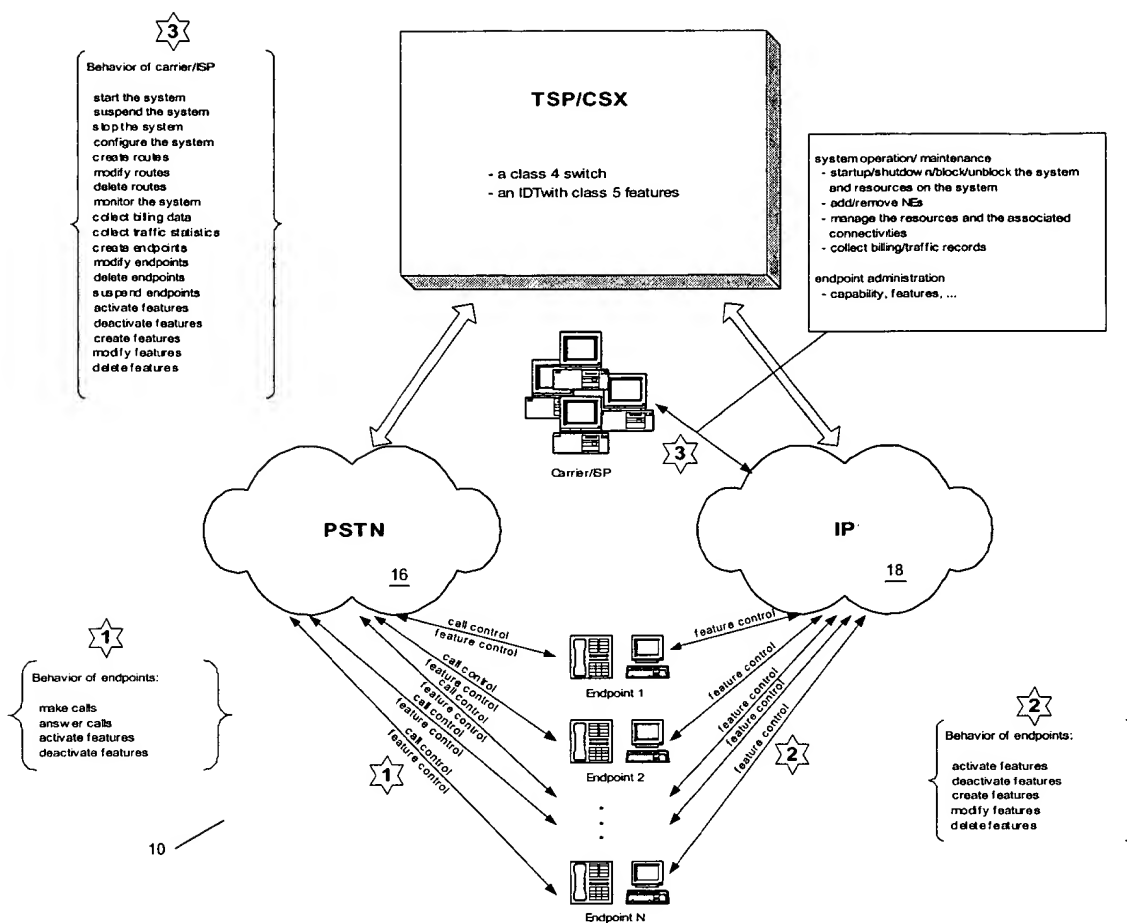


Figure 2

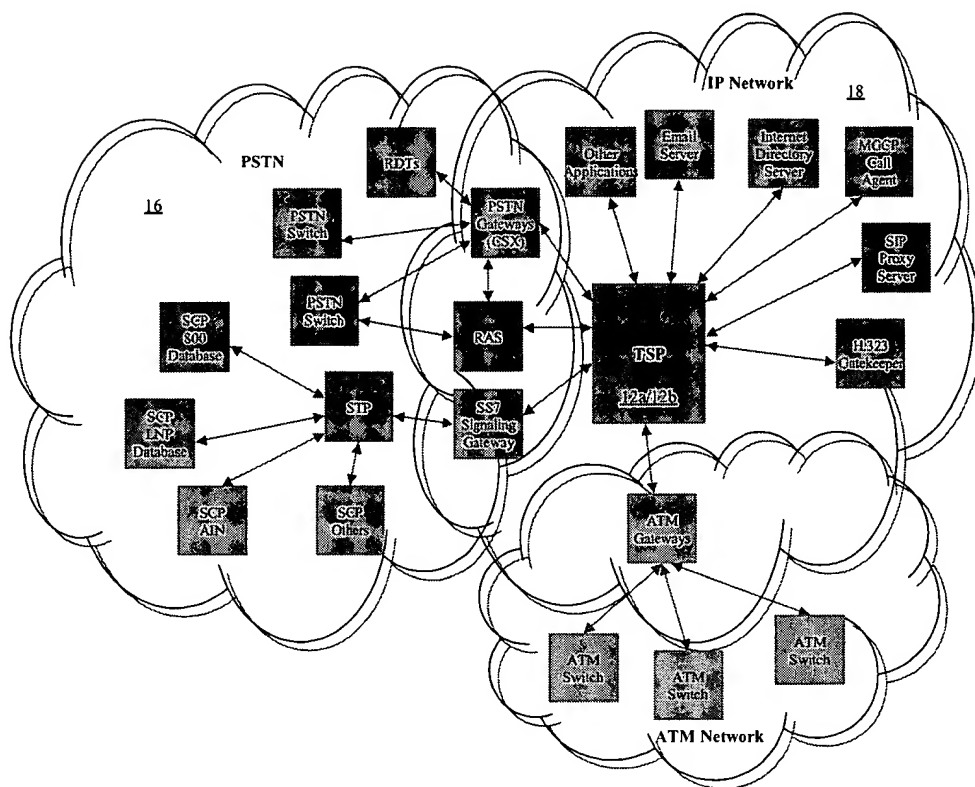


Figure 3

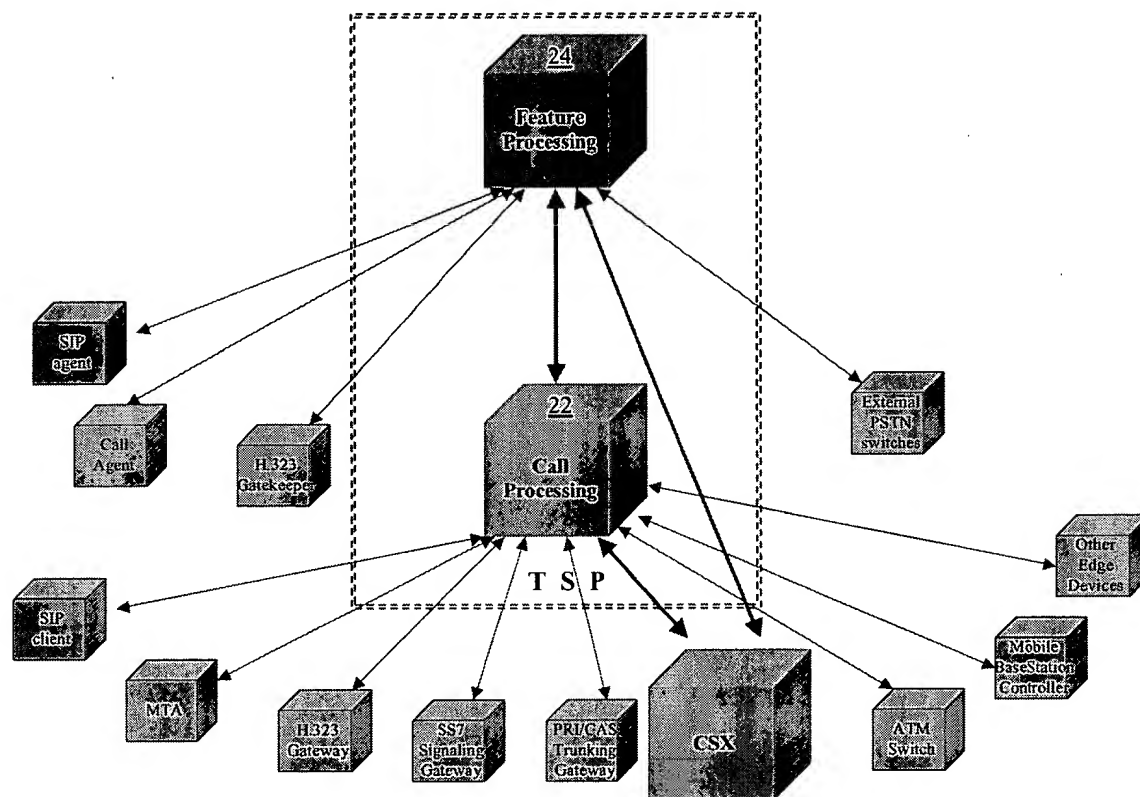


Figure 4

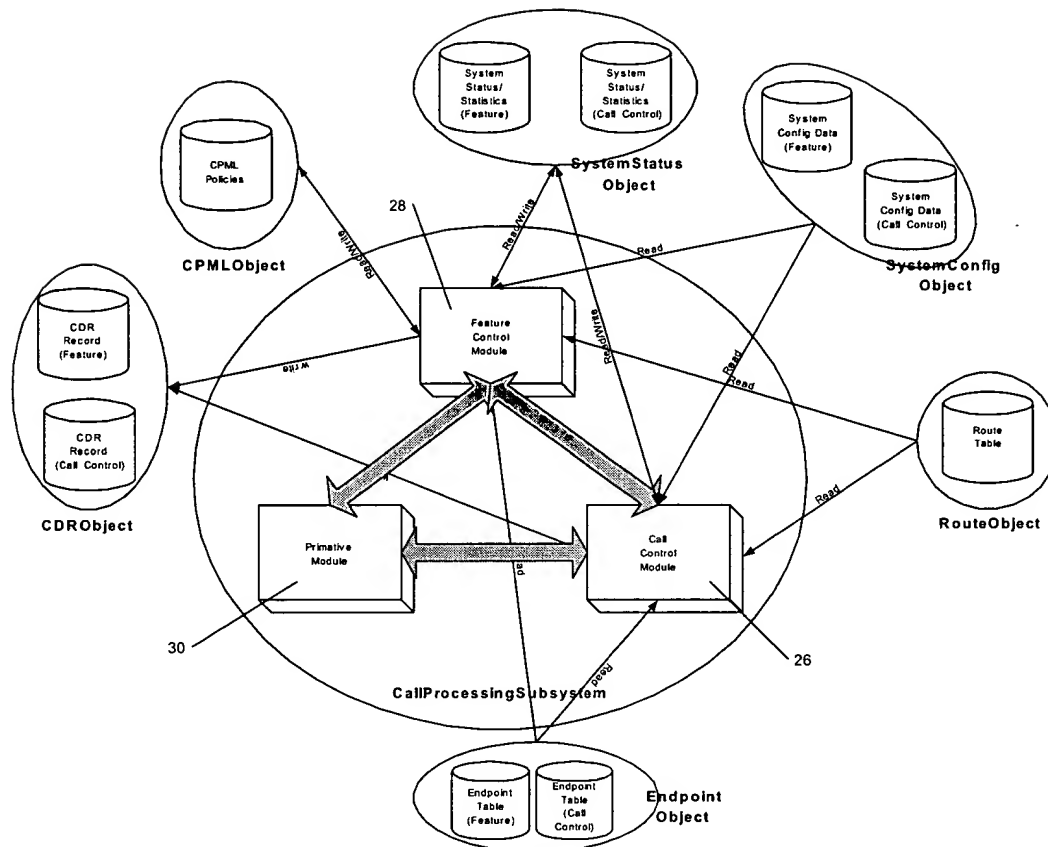


Figure 5

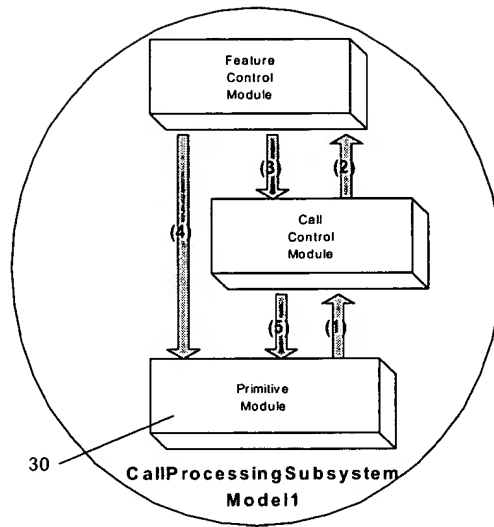


Figure 6A

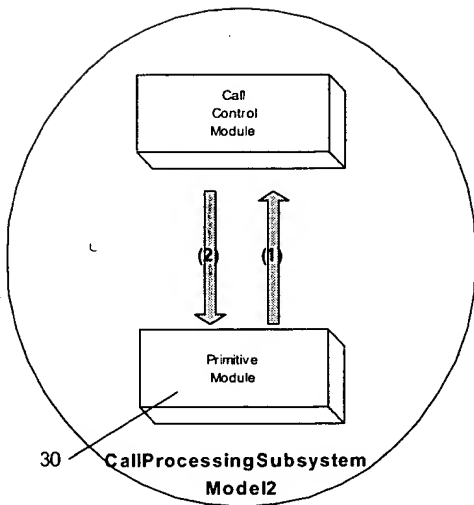


Figure 6B

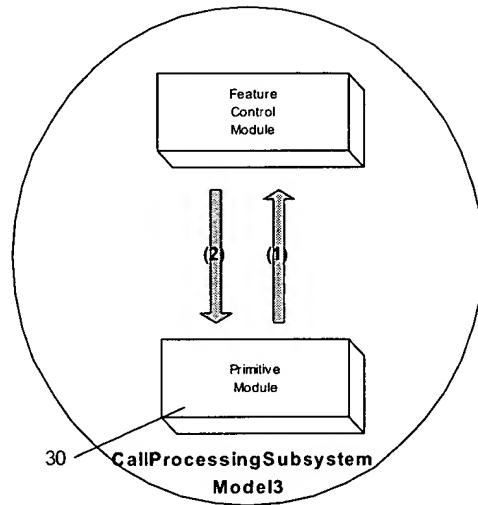


Figure 6C

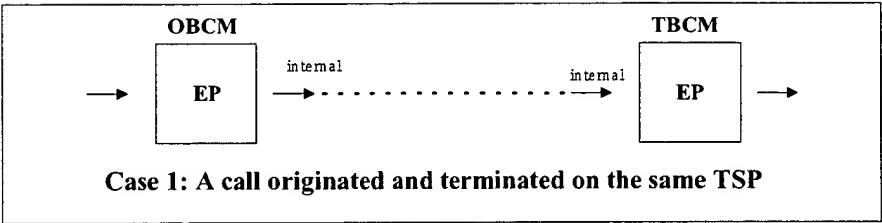


Figure 7A

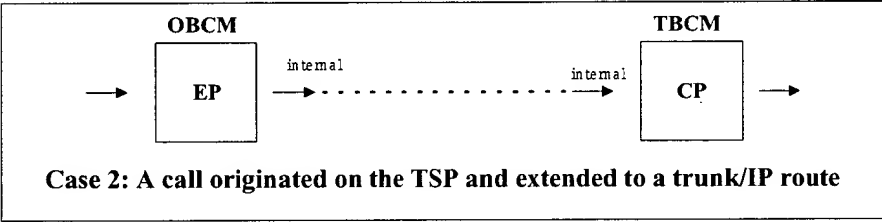


Figure 7B

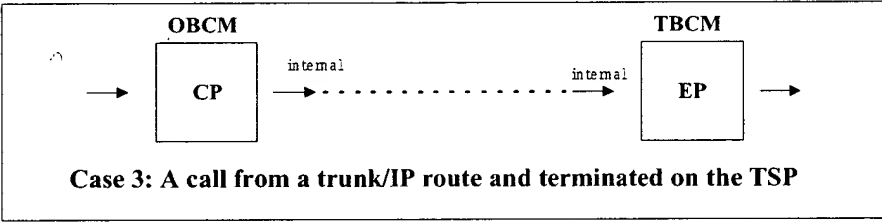


Figure 7C

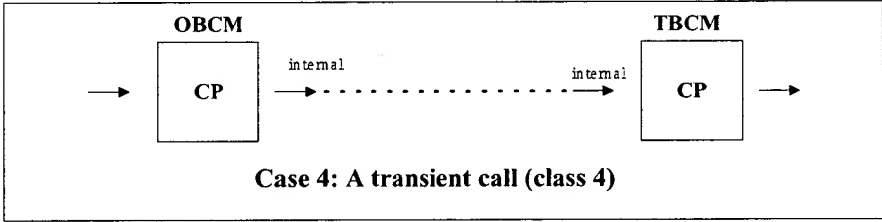


Figure 7D

30A

Feature Mask	Feature Logic Object
000	NULL
001	CND_FLO
010	CFBL_FLO
011	CFBL_FLO
100	CW_FLO
101	CW_CND_FLO
110	CW_CFBL_FLO
111	CW_CFBL_CND_FLO

feature mask = abc where

bit a – Call Waiting (CW)

bit b – Call Forwarding Busy Line (CFBL)

bit c – Calling Number Delivery (CND)

User defined features are not included in this table.

Figure 8

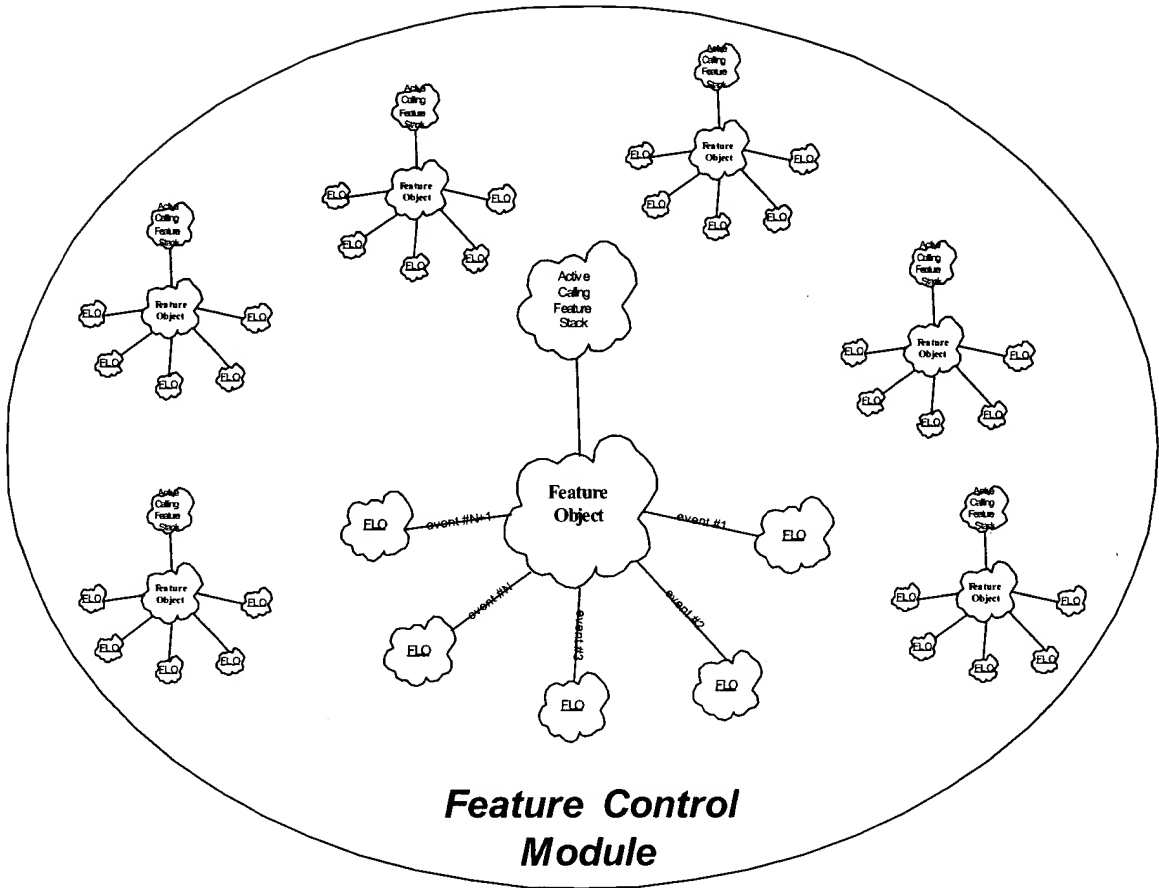


Figure 9

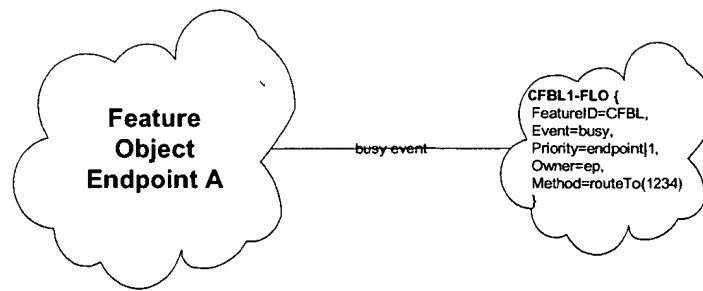


Figure 10A

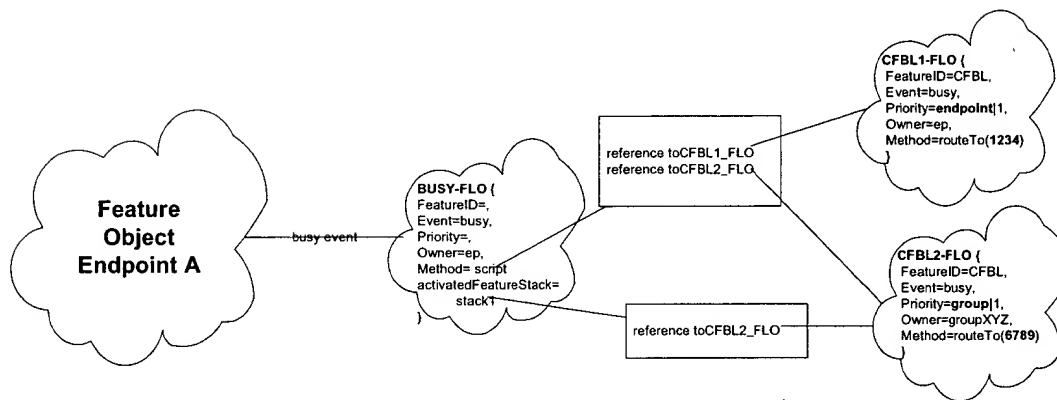


Figure 10B

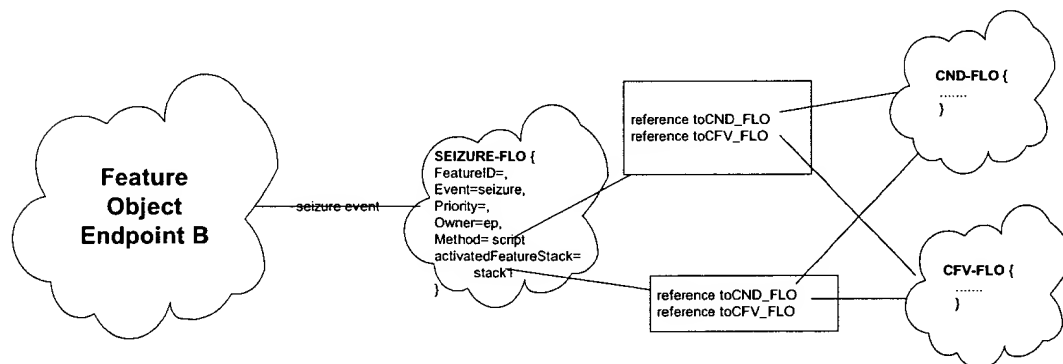


Figure 10C

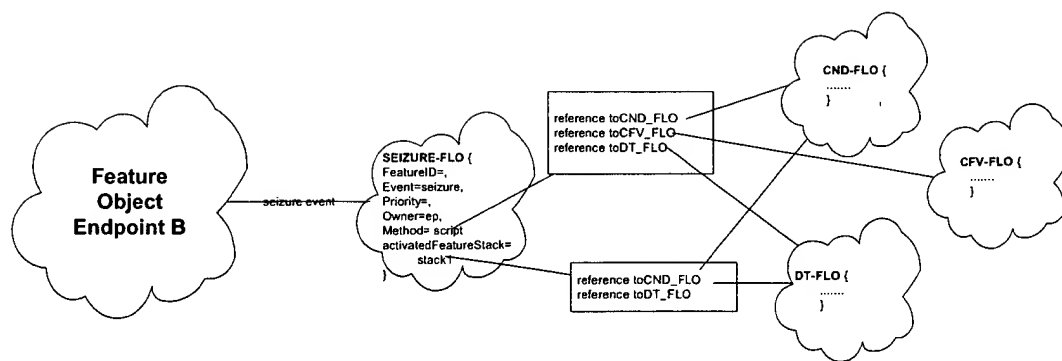


Figure 10D

FIG. 10D

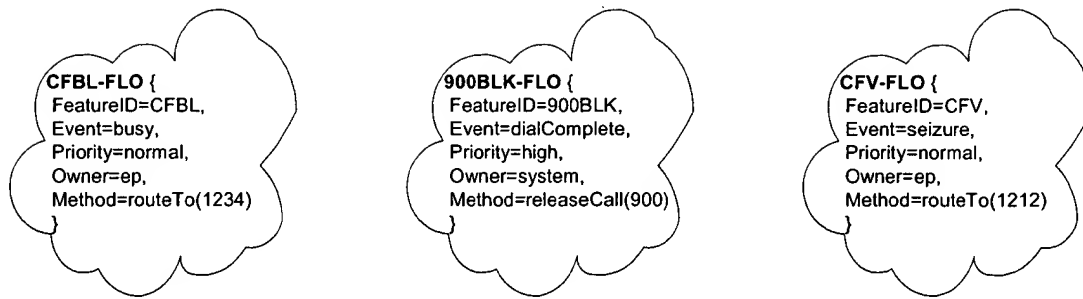


Figure 11A

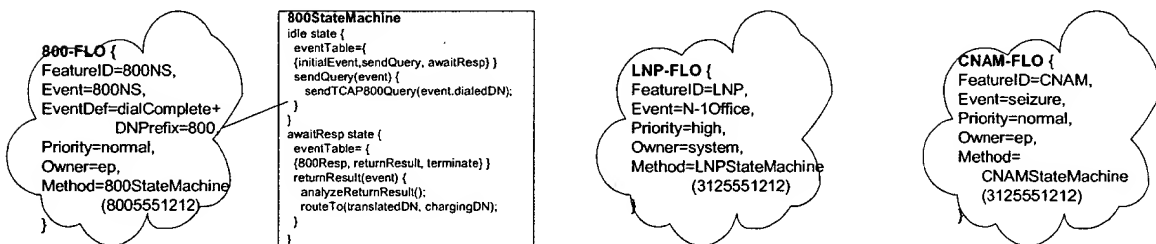


Figure 11B

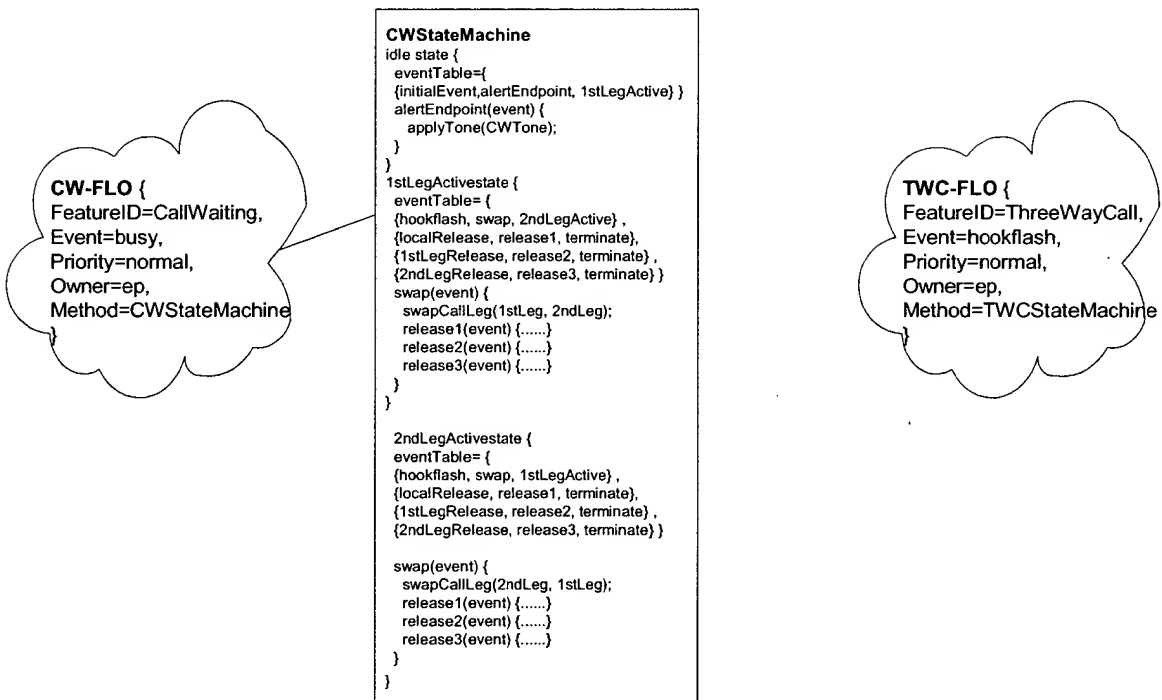


Figure 11C

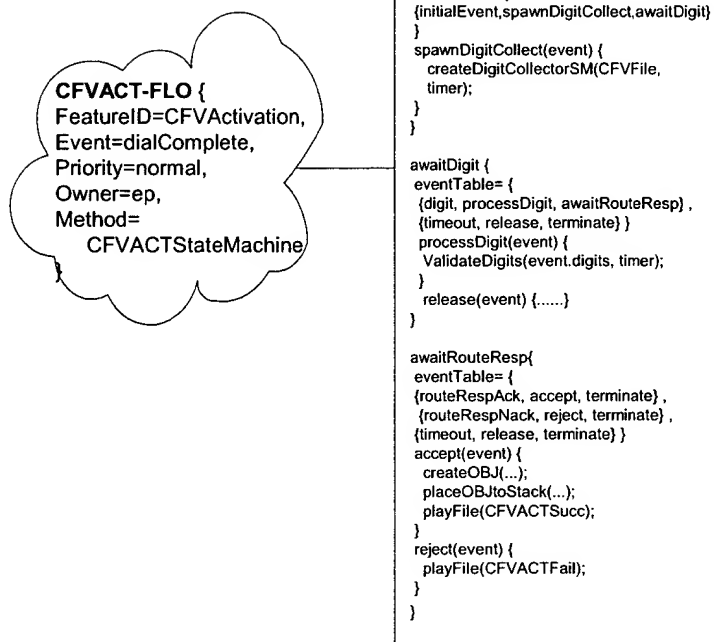


Figure 11D

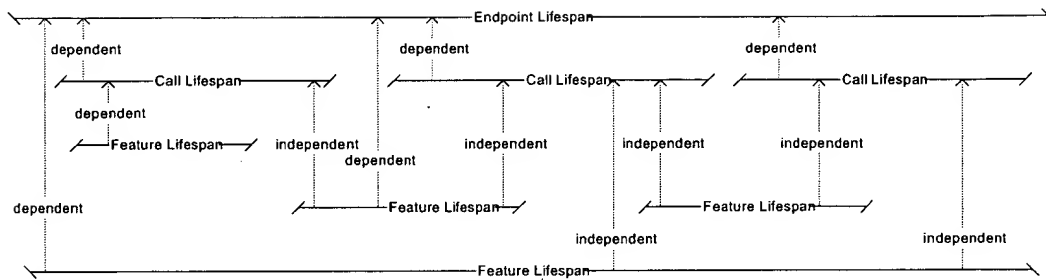


Figure 12

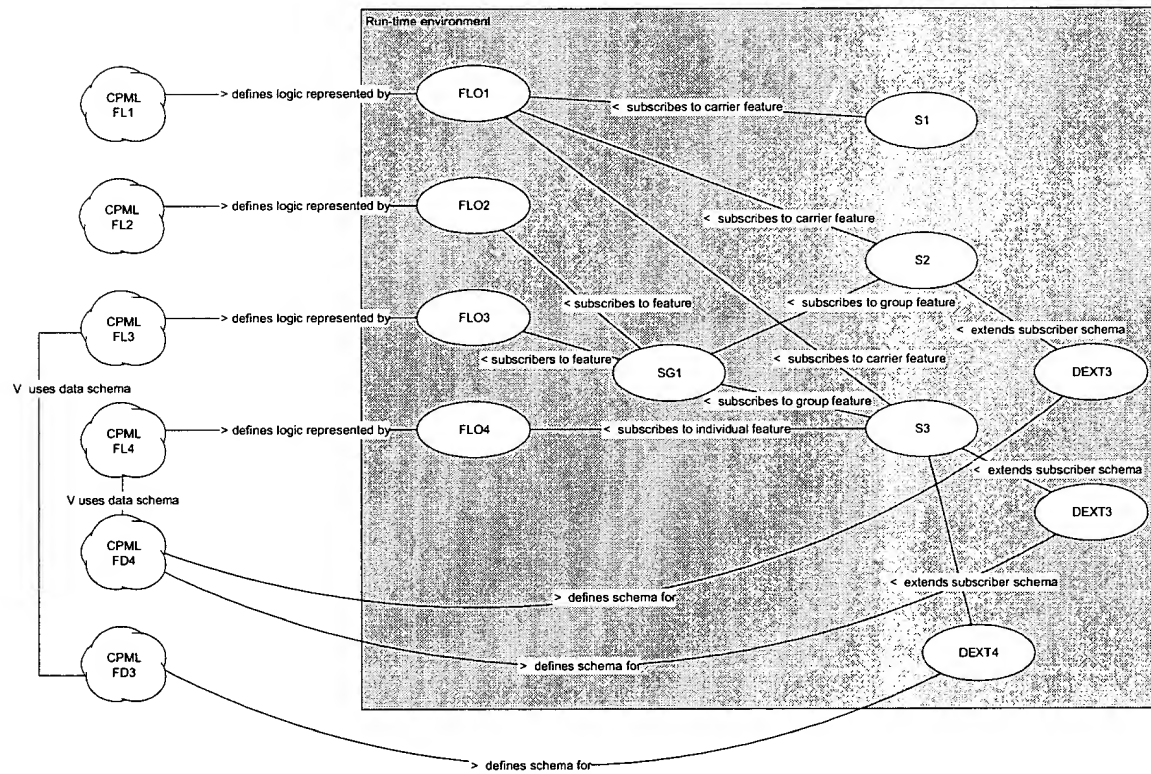


Figure 13

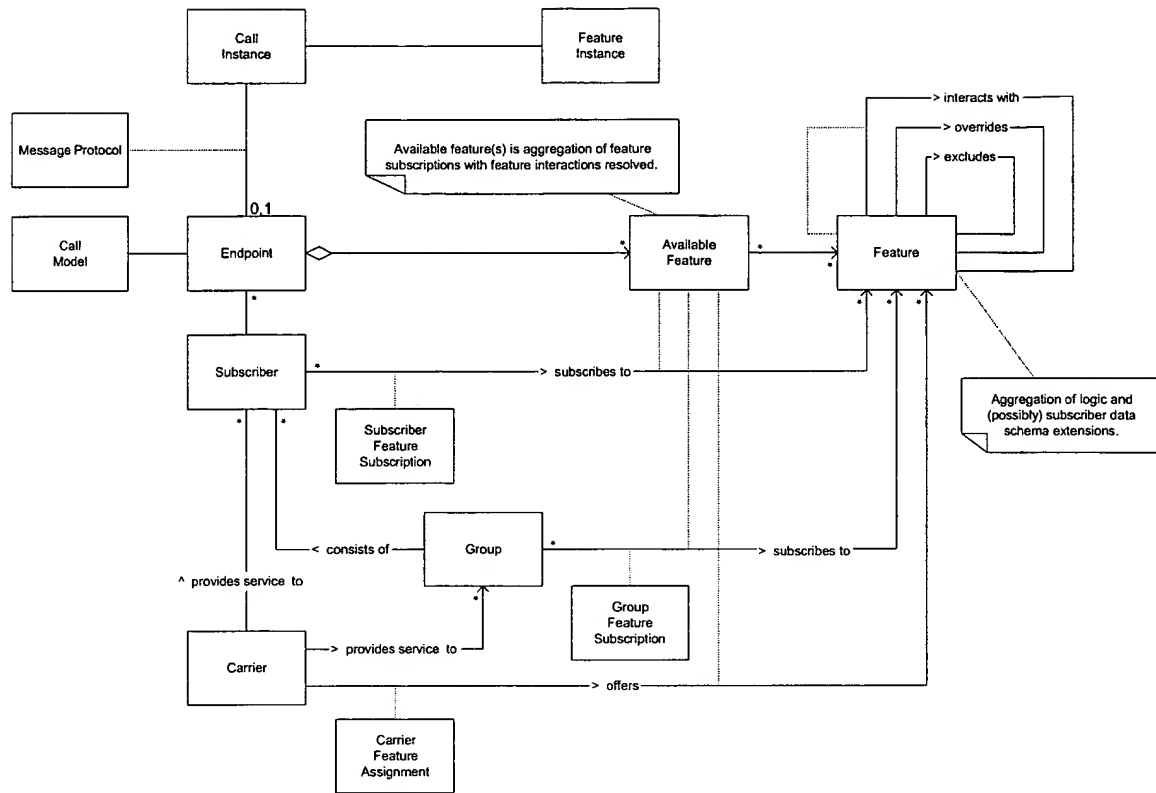


Figure 14

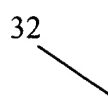


Figure 15

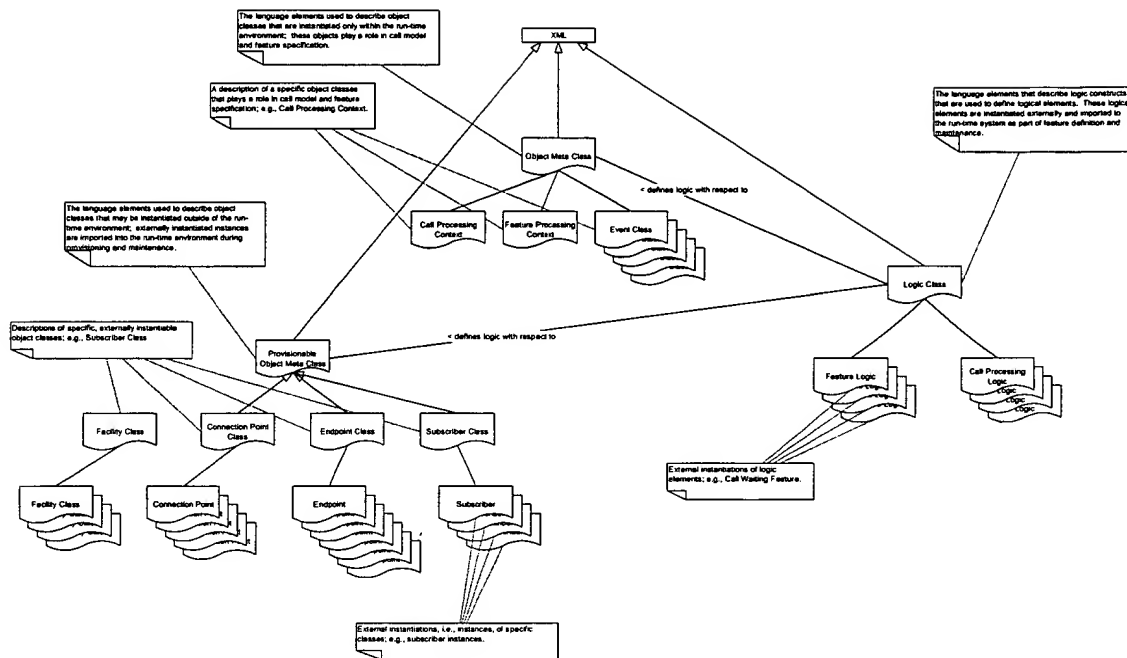


Figure 16

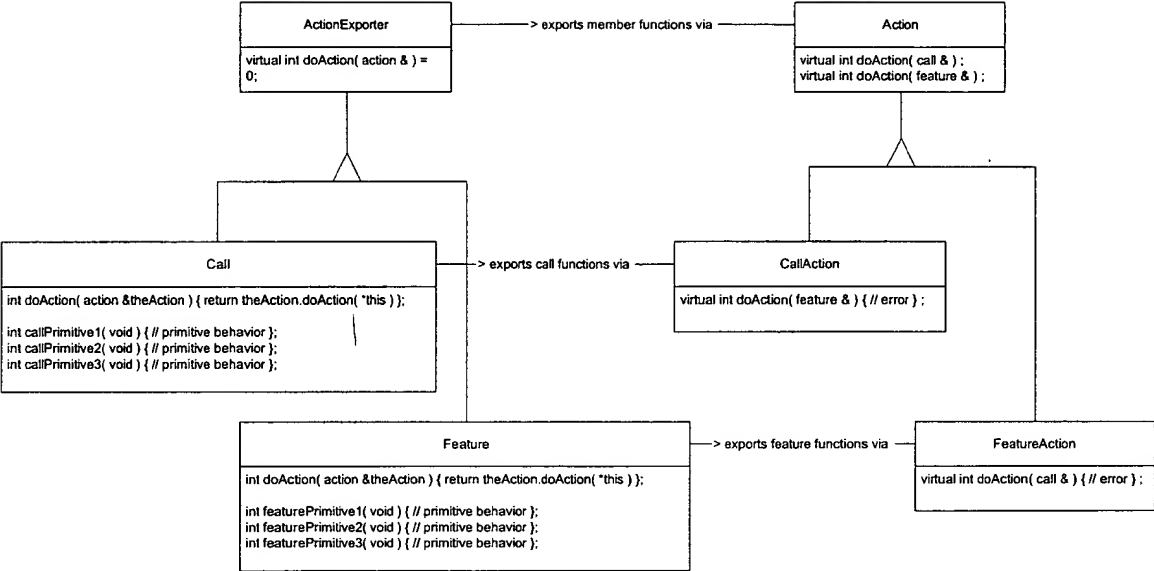


Figure 17

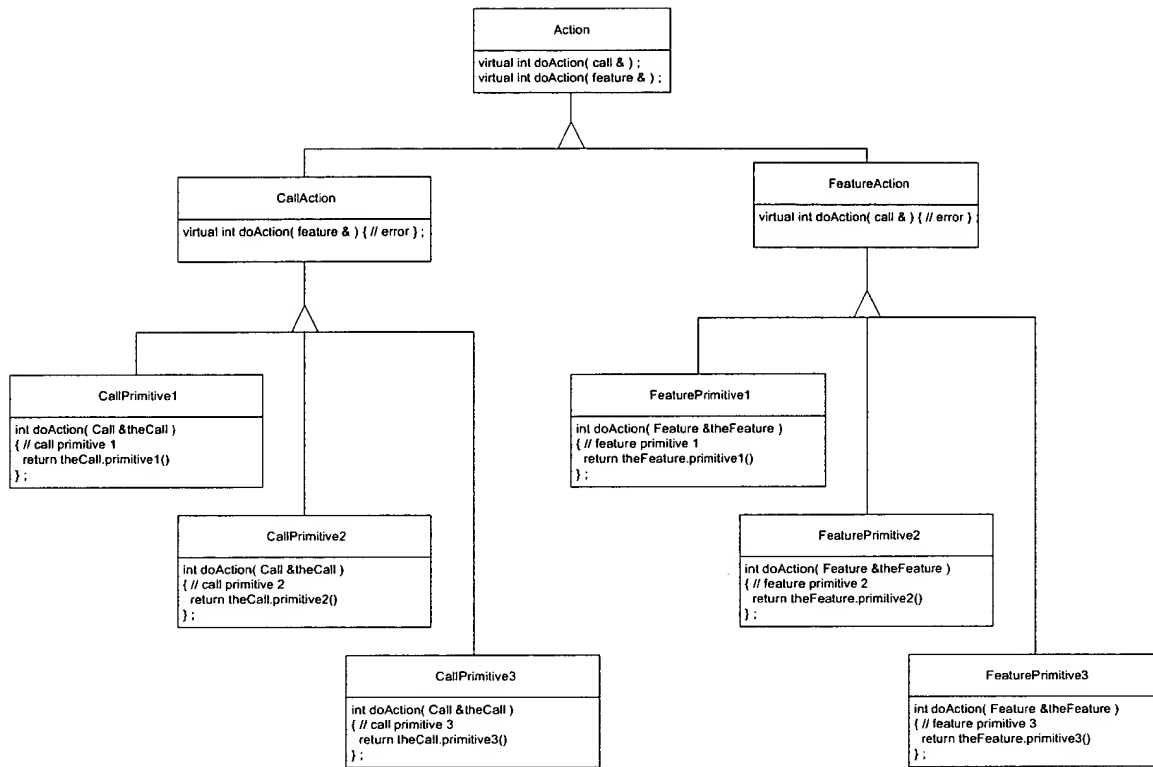
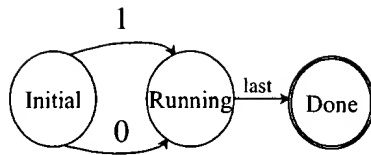


Figure 18



```

(EventParityLogic
  (Initial (1Bit (()) (Set odd) (Running))
    (0Bit (()) (Set even) (Running))
    (Last (()) (Print "Error!") (Initial))
  )
  (Running (1Bit ((IsOdd?) (Set even) (Running))
    ((IsEven?) (Set odd) (Running))
    )
    (0Bit (()) (Running))
    (Last ((IsOdd?) (Print "Bad!") (Done))
      ((IsEven?) (Print "Good!") (Done))
    )
  )
  (Done ()))
)

```

```

(AddParityLogic
  (Initial
    (1Bit (i) (Set odd) (Running))
    (0Bit (i) (Set even) (Running))
    (Last (i) (Print "Error!") (Initial))
  )
  (Running
    (1Bit ((IsOdd?)) (Set even) (Running))
    ((IsEven?) (Set odd) (Running))
    (0Bit (i) (i) (Running))
    (Last ((IsOdd?) (Print "Good!") (Done))
      ((IsEven?) (Print "Bad!") (Done))
    )
  )
  (Done (i))
)

```

Figure 19

```

(LogicName
  (StateName
    (EventName
      ((Predicate)
        (ActionName {})
        (ActionName (ParamSpec,...))
        (StateName)
      )
      (()) (ActionName (ParamSpec,...))
        (ActionName (ParamSpec,...))
        (StateName)
      )
    )
    (EventName
      ((Predicate)
        (ActionName (ParamSpec,...))
        (ActionName (ParamSpec,...))
        (StateName)
      )
      (()) (ActionName (ParamSpec,...))
        (ActionName (ParamSpec,...))
        (StateName)
      )
    )
  )
  (StateName
    (EventName
      ((Predicate)
        (ActionName (ParamSpec,...))
        (ActionName (ParamSpec,...))
        (StateName)
      )
    )
  )
)

```

Figure 20

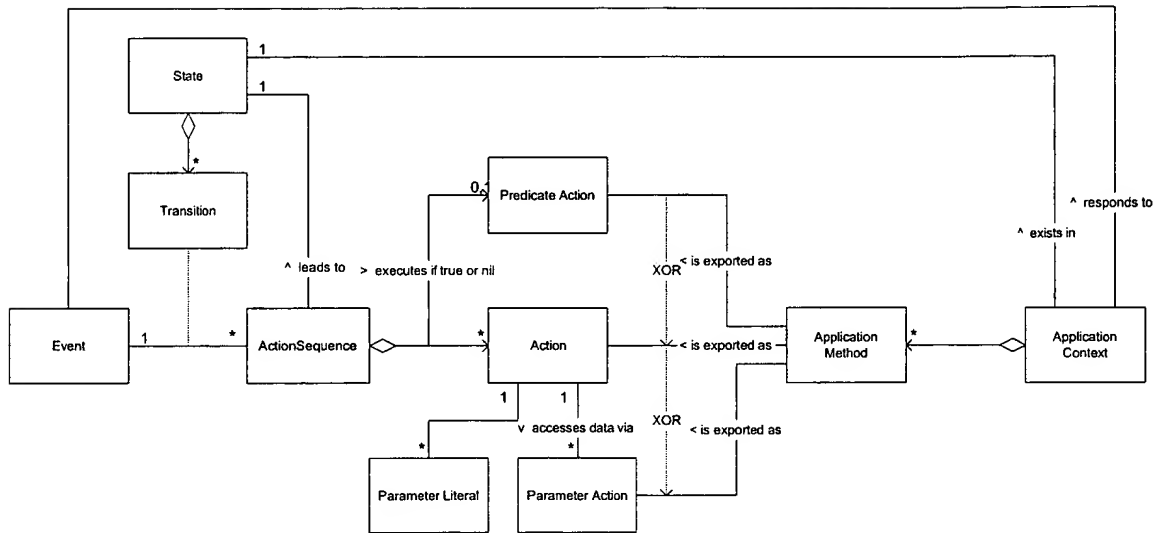


Figure 21

1. The first part of the paper is devoted to the study of the asymptotic behavior of the solutions of the system (1) as $t \rightarrow \infty$. It is shown that the solutions of the system (1) are bounded and tend to zero as $t \rightarrow \infty$.

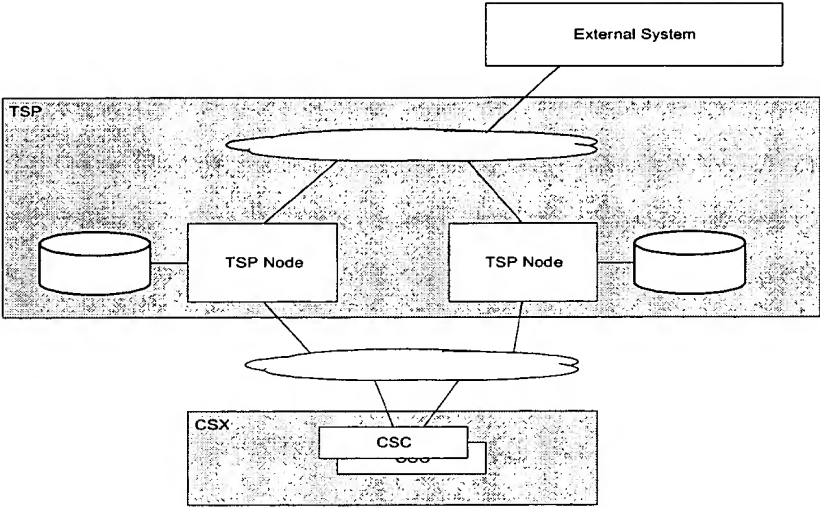


Figure 22

FIG. 22

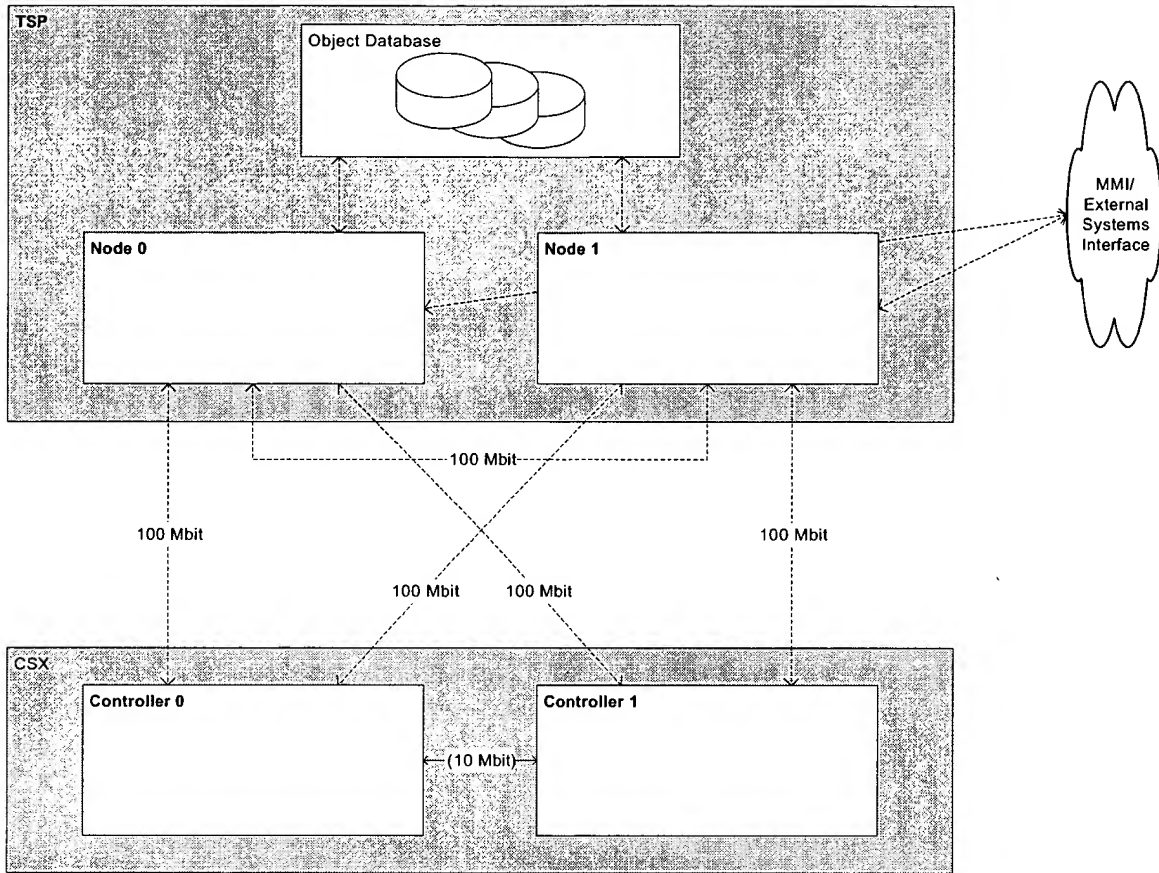


Figure 23

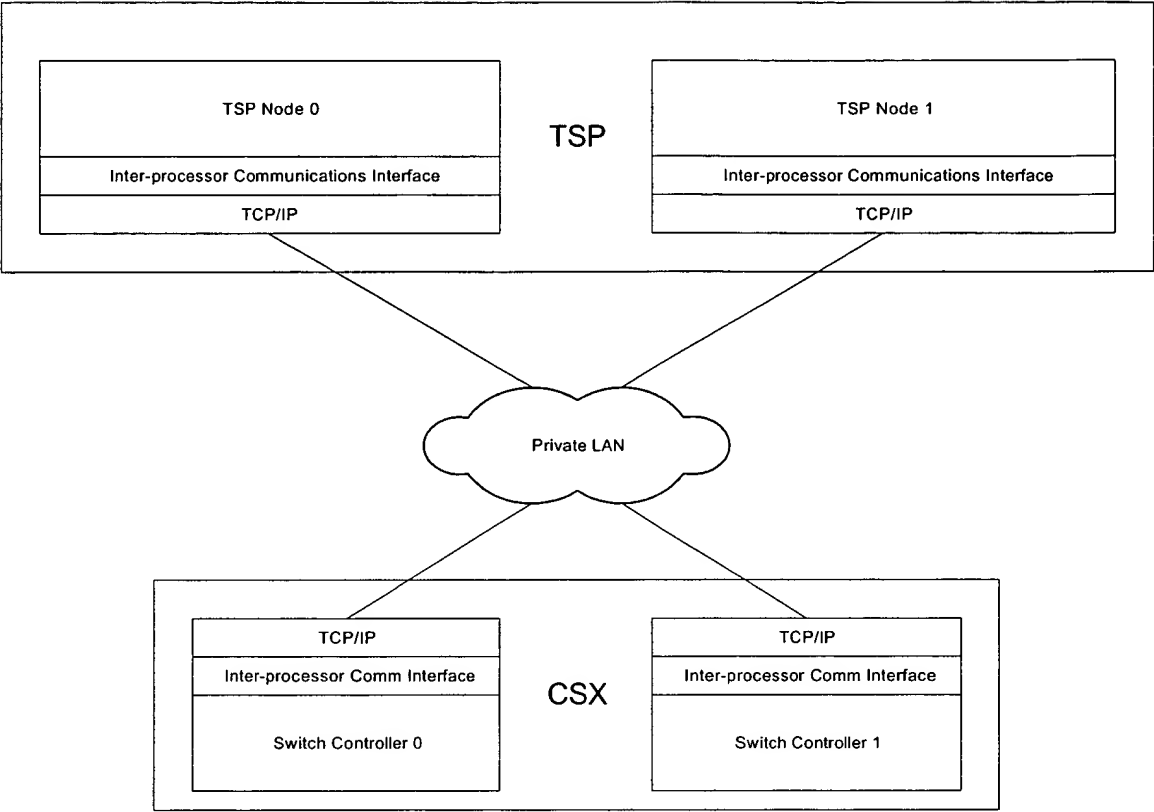


Figure 24

Figure 24 is a block diagram of a network architecture. The diagram shows two main components, TSP (Top System Processor) and CSX (Control System eXecutor), connected via a Private LAN. The TSP component contains two nodes, TSP Node 0 and TSP Node 1. Each node has an Inter-processor Communications Interface and a TCP/IP interface. The CSX component contains two switch controllers, Switch Controller 0 and Switch Controller 1. Each controller has an Inter-processor Comm Interface and a TCP/IP interface. The Private LAN is represented by a cloud in the center. Lines connect the TCP/IP interfaces of TSP Node 0 and Switch Controller 0, TSP Node 1 and Switch Controller 1, and both switch controllers to the Private LAN cloud.

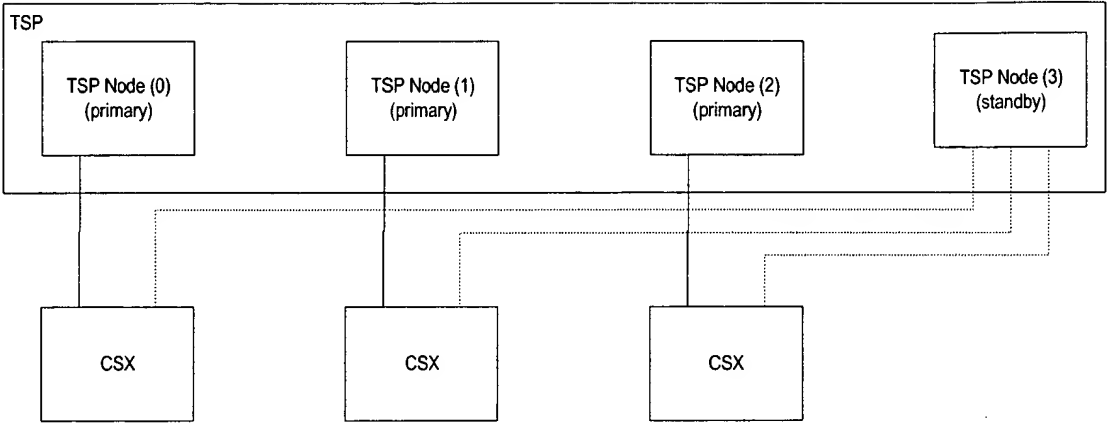


Figure 25

FIG. 25

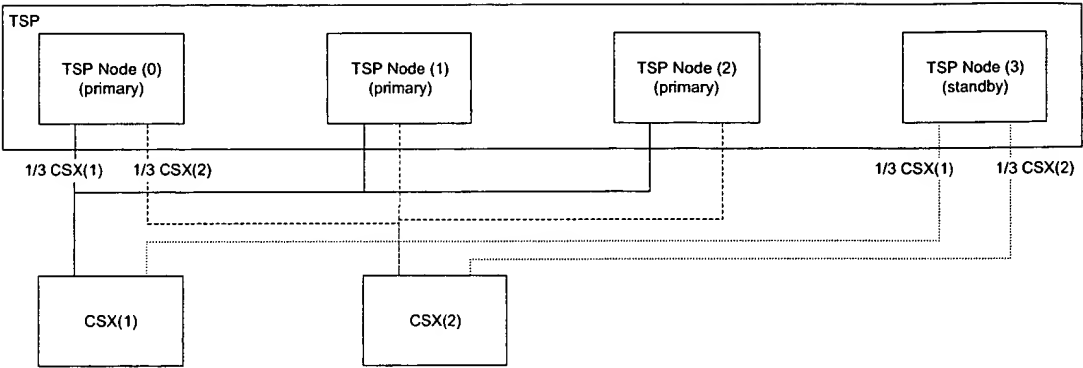


Figure 26

Figure 26

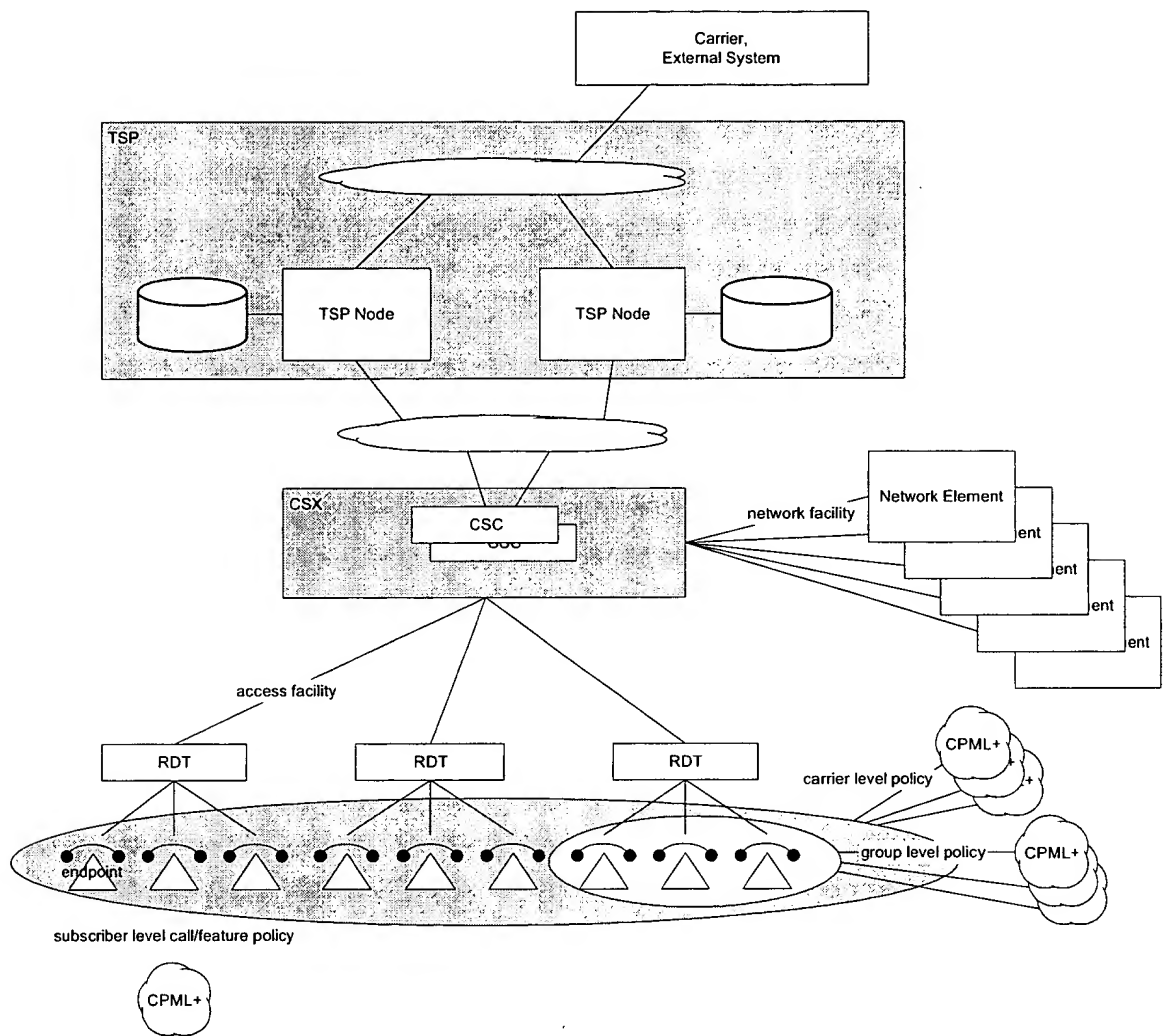


Figure 27

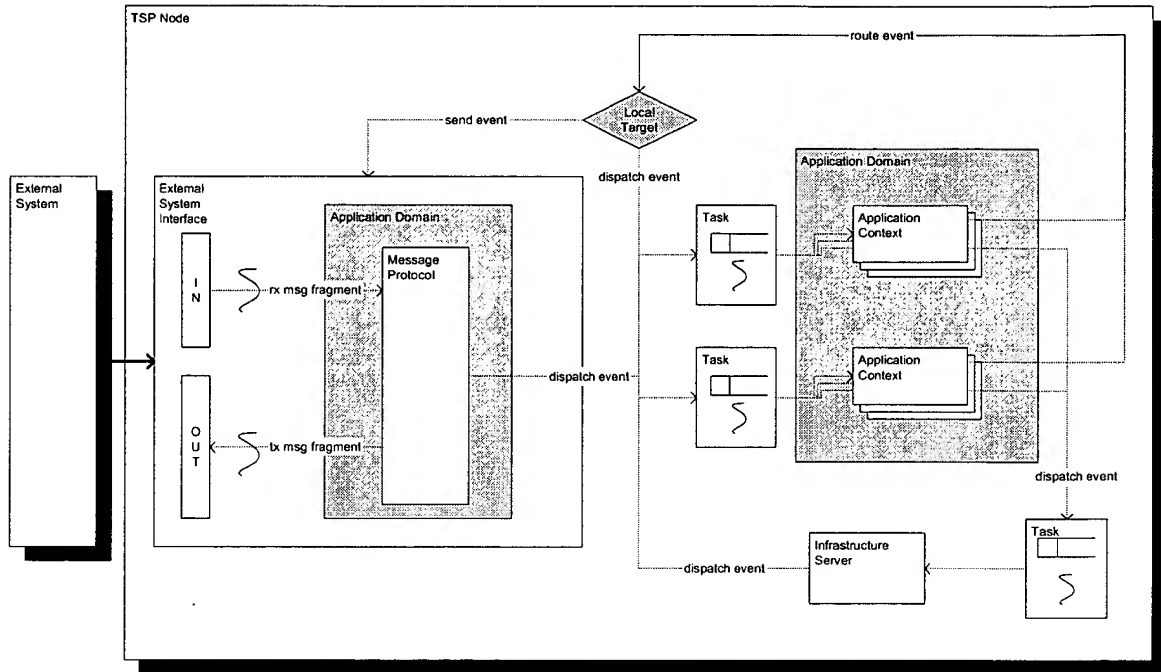


Figure 28A

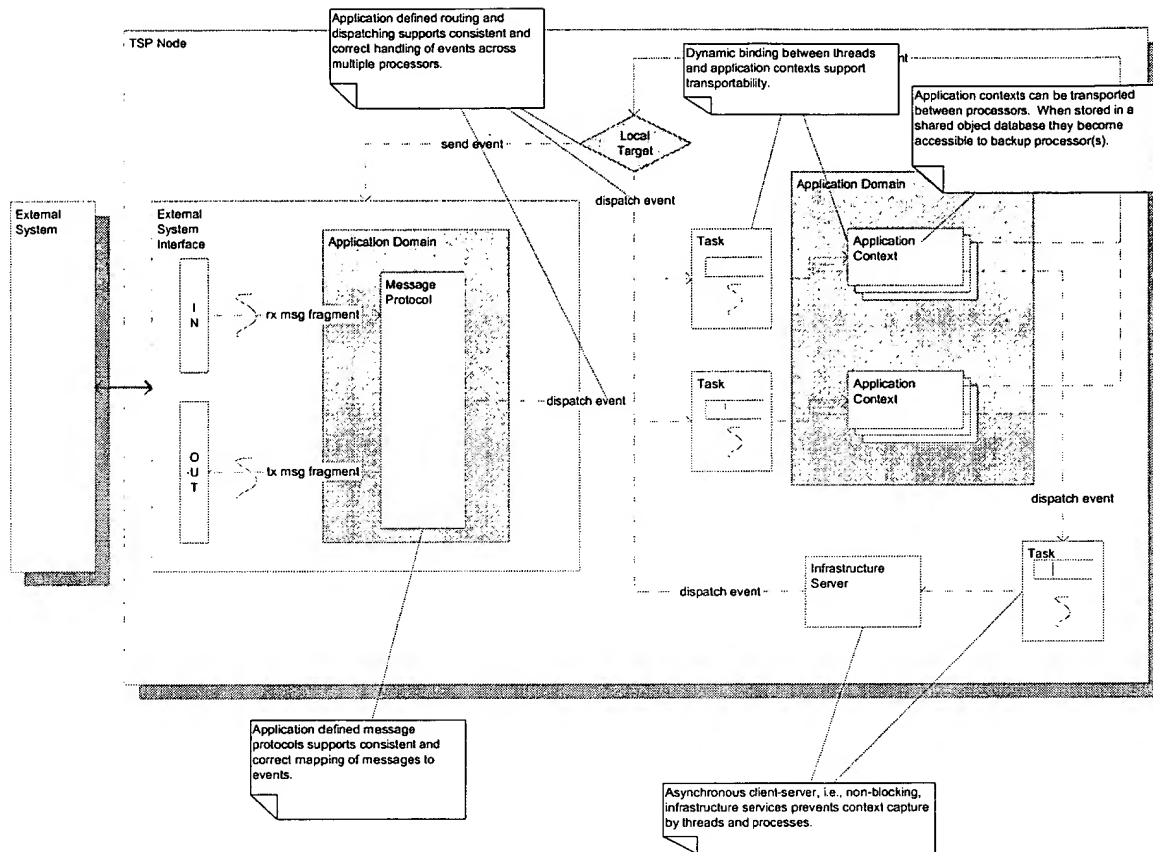


Figure 28B

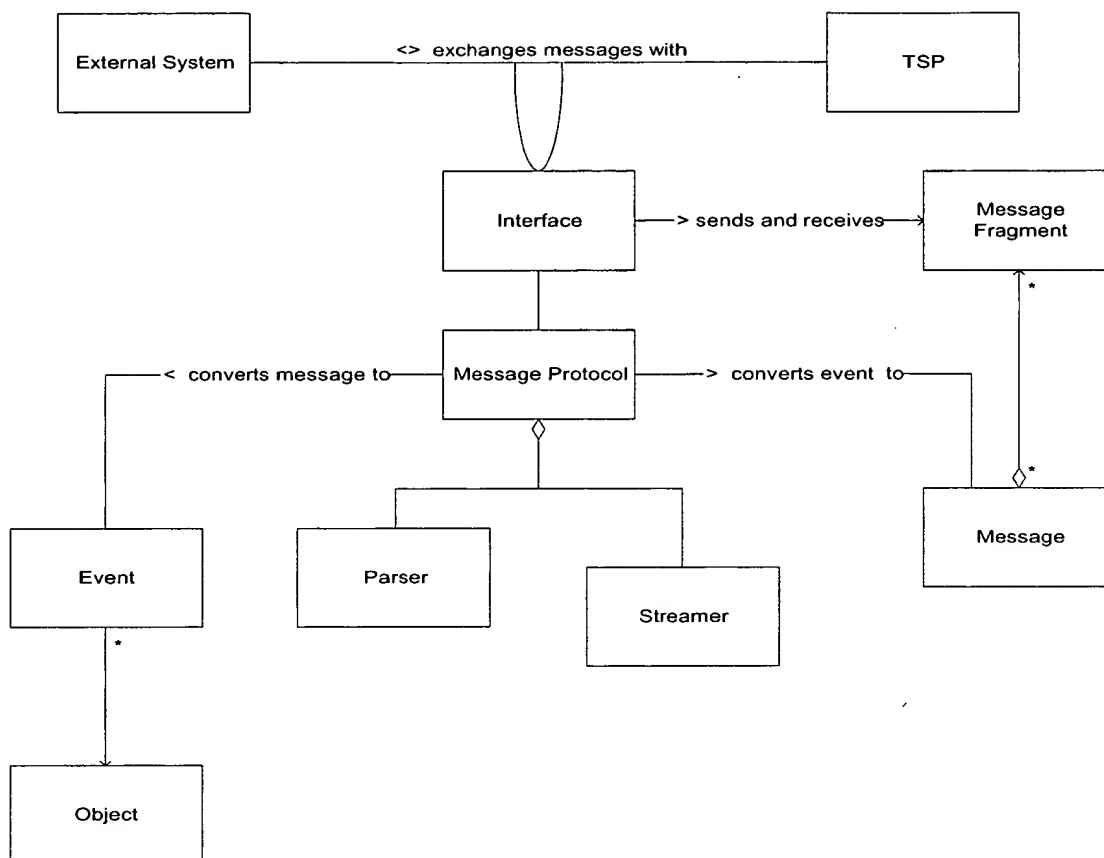


Figure 29

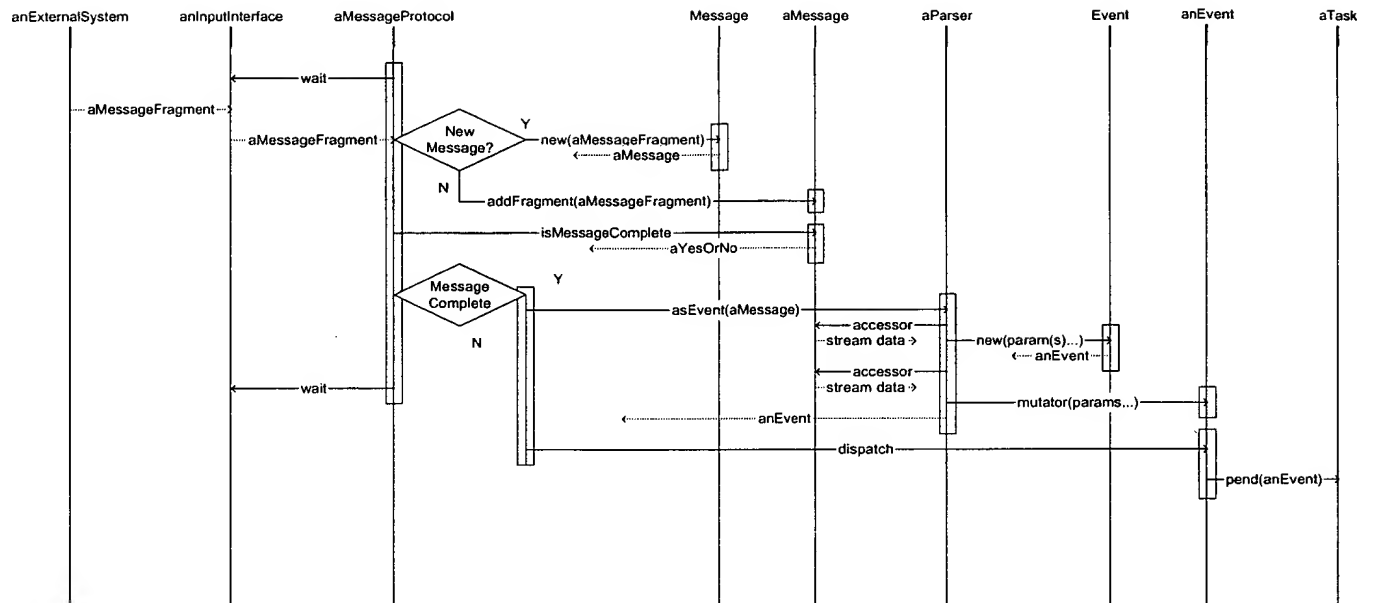


Figure 30A

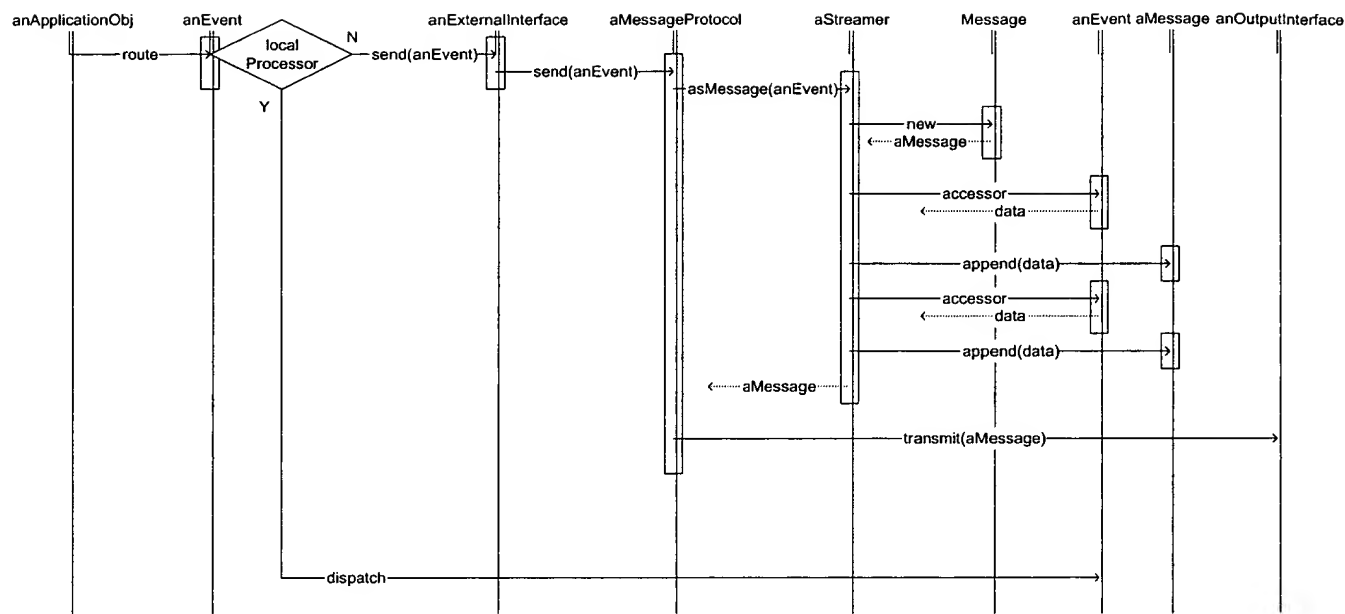
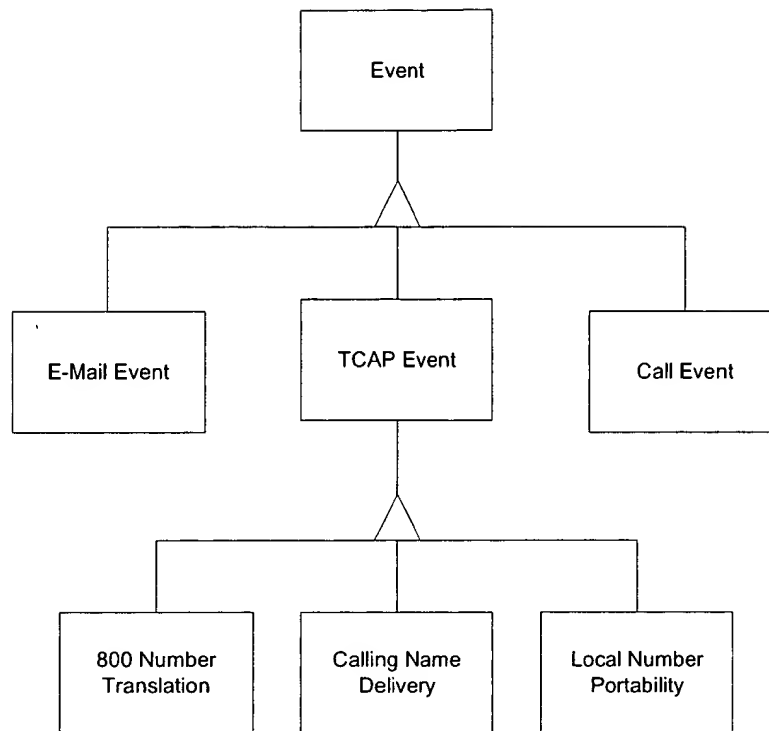


Figure 30B

**Figure 31**

Call/Feature Policy

Definition	Describes call and feature processing behavior.
Native Format	ASCII based markup (CPML, CPML+) for external usage and maintenance. Object(s) for internal processing.
Source/Authority	Service maintenance and provisioning; the TSP/CSX product provides standardized call and class 5 feature definitions. Service Creation Environment (tool?) provides capability to create new or modify existing call and/or feature policies.
Value Initiation Frequency (Low)	Assuming that most policies are defined at carrier or group levels, new call and feature policies with the introduction of new group level call and features types. This frequency is less than the subscriber provisioning frequency. For individual level call and feature types, call and feature policies may be introduced coincident with the provisioning of new subscribers.
Value Change Frequency (Low to Moderate)	In general, call and feature logic elements change infrequently—when call or feature logic is modified or upgraded. This frequency is less than the subscriber provisioning frequency. Call and feature parameter elements, e.g., call forwarding destination number, may change at or above the subscriber provisioning frequency. Some parameter elements may change as much as hourly.
Value Access Frequency (High)	Call and feature policies, including logic and parameter elements, are accessed with each call.
Schema Change Frequency (Low)	Call and feature policy schemas define the structure with which calls and call features are described. Once mature, the schema for defining calls and features should change very infrequently; only as often as needed to upgrade call type and feature specification capabilities.
Consumer(s)	Call and feature processing.
Consumer Format	Object(s)
Replications and Sharing	TSP nodes share call and feature processing specifications.
Scope	System, Group, and Individual Subscriber
Volume	Group and system level logic elements have few instances. Individual level logic elements are coincident with subscriber volumes. Parameter element volumes are a function of the number of parameterized features in combination with the subscriber population size.

Figure 32A

Figure 32B

Endpoint/Subscriber

Definition	Describes endpoint devices (within scope of TSP/CSX), the configuration of those devices, subscribers associated with endpoint devices, and associates endpoint(s)/subscriber(s) with call and feature policies.
Native Format	
Source/Authority	Subscriber care (subscriber provisioning and maintenance).
Value Initiation Frequency (Low)	Endpoint/subscriber instances are initiated as new subscribers are added to the carrier's subscriber base. Call and feature policy associations are initiated as new call types and features are deployed and as subscribers subscriber to different services.
Value Change Frequency (Low)	Value changes occur as subscribers modify their calling and/or feature parameters.
Value Access Frequency (High)	Endpoint/subscriber data is accessed with each call.
Schema Change Frequency (Low to Moderate)	Endpoint schema changes only with software product upgrades. Subscriber schema may be extended through introduction of new features.
Consumer(s)	Call and Feature processing.
Consumer Format	Object
Replications and Sharing	Multiple TSP nodes share Endpoint/subscriber data.
Scope	
Volume	Endpoint/subscriber volumes equal the carrier's subscriber population.

Figure 32C

TSP/CSX "32C" 32C

Call/Feature State

Definition	Describes the current state of calls and/or call features.
Native Format	Object
Source/Authority	Call and Feature Processing; call and feature state data is generated and maintained for each call and/or feature.
Value Initiation Frequency (High)	Call state instances are initiated with each call. Feature state instances are initiated as needed based on call level events.
Value Change Frequency (High)	Call and feature state changes occur in response to events throughout the life of the associated call and/or feature(s).
Value Access Frequency (High)	Call and feature state are accessed in order to service events throughout the life of the associated call and/or feature(s).
Schema Change Frequency (Low)	Call and feature state objects a combination of native application objects and instantiations of call and feature policy schemas. Native object schemas change only with product software upgrades. Call and feature policy schema changes are addressed elsewhere.
Consumer(s)	Call and feature processing.
Consumer Format	Object
Replications and Sharing	Call and feature states are replicated in support of fault tolerance capabilities.
Scope	
Volume	Call and feature volumes are a function of the subscriber population combined with the subscriber's calling frequency constrained by transmission capabilities.

Figure 32D

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Equipment/Facility

Definition	Describes an equipment item or a transmission facility, and the configuration of that equipment item or transmission facility. Equipment items include processor devices, remote data terminals, intelligent peripherals, etc. Transmission facilities include network facilities, which connect a CSX to an external network element, and access facilities, which provide endpoints with access to the carrier's network.
Native Format	MIB?
Source/Authority	OAM&P
Value Initiation Frequency (Low)	New equipment descriptions are introduced when the carrier adds new equipment components. New network facilities are introduced when the carrier adds new transmission facilities.
Value Change Frequency (Low)	Changes in equipment and transmission facility descriptions and configurations are rare once provisioned and stable.
Value Access Frequency (Low)	Equipment and transmission facility descriptions and configurations are accessed only during system initialization and re-boots.
Schema Change Frequency (Low)	Equipment and transmission facility schemas change only support for new equipment and/or transmission types is added to the product.
Consumer(s)	System initialization and OA&P processes.
Consumer Format	
Replications and Sharing	TSP nodes share some of the equipment and transmission facility description and configuration data. TSP and CSX elements share certain categories of equipment and transmission facility descriptions and configurations.
Scope	
Volume	This is a function of the count of equipment items and transmission facilities.

Figure 32E

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Definition	Describes the present state of an equipment item or a transmission facility.
Native Format	MIB?
Source/Authority	OA&M processes, certain aspects of call processing. NMS may command state changes.
Value Initiation Frequency (Low)	Equipment and facility states are initiated during system initialization and re-boots.
Value Change Frequency (Moderate to High)	Certain types of equipment and transmission facilities change state frequently. Other types change state with only moderate frequency. Aggregate equipment and facility states change with less frequency than individual components.
Value Access Frequency (Varies from Low to High)	In general, this data is accessed at NMS polling intervals. State data that contributes to statistics may be sampled at frequent intervals.
Schema Change Frequency (Low)	Equipment and facility state schemas change only with product upgrades.
Consumer(s)	NMS
Consumer Format	MIB?
Replications and Sharing	Multiple TSP nodes may share certain state elements. Certain equipment and facility state elements may be replicated for redundancy support.
Scope	
Volume	This is a function of the count of equipment items and transmission facilities.

Figure 32F

Equipment/Facility Statistics

Definition	Describes a usage or event occurrence history with respect to a particular equipment item or facility.
Native Format	MIB?
Source/Authority	OA&M processes, certain aspects of call processing.
Value Initiation Frequency (Low)	Values are initiated during system initialization and re-boots.
Value Change Frequency (Moderate to High)	Statistics on directly measured attributes change with the frequency of related events. Statistics on sampled attributes change with the sampling frequency.
Value Access Frequency (Low to Moderate)	These values are accessed at collection and polling intervals.
Schema Change Frequency (Low)	Statistic schema changes occur only with product upgrades.
Consumer(s)	NMS, OAM&P
Consumer Format	SNMP Messages, ASCII based markup logs
Replications and Sharing	
Scope	
Volume	Statistics volume is a function of measurement method, measurement intervals, and count of sampled entities.

Figure 32G

Automated Message Accounting (AMA)

Definition	Describes call and feature usage characteristics relevant to call and feature billing.
Native Format	AMA data is packed binary coded decimal. Historically, AMA data is stored and/or transmitted in blocks according to a standard tape record format.
Source/Authority	Billing related processing; AMA records are generated from CDRs.
Value Initiation Frequency (Low)	AMA records are most likely generated according to an internal schedule, perhaps once or twice daily. AMA generation may occur on demand when polled by an external system. AMA or as specified by call and/or feature definitions to support real-time bill calculation/accounting.
Value Change Frequency (Static)	AMA records are static once generated.
Value Access Frequency (Low)	In general, AMA records are accessed only when passed to an external system for processing—under nominal circumstances this occurs once for each record. Additional accesses may occur to support recovery of an external processing exception.
Schema Change Frequency (Low)	New AMA schemas may be introduced with new service introductions. Existing AMA record schemas are defined by Telcordia standards and therefore change infrequently.
Consumer(s)	External bill processing system.
Consumer Format	AMA
Replications and Sharing	AMA data need not be replicated or shared among TSP processing nodes.
Scope	System
Volume	AMA volumes are a function of call/ feature volume.

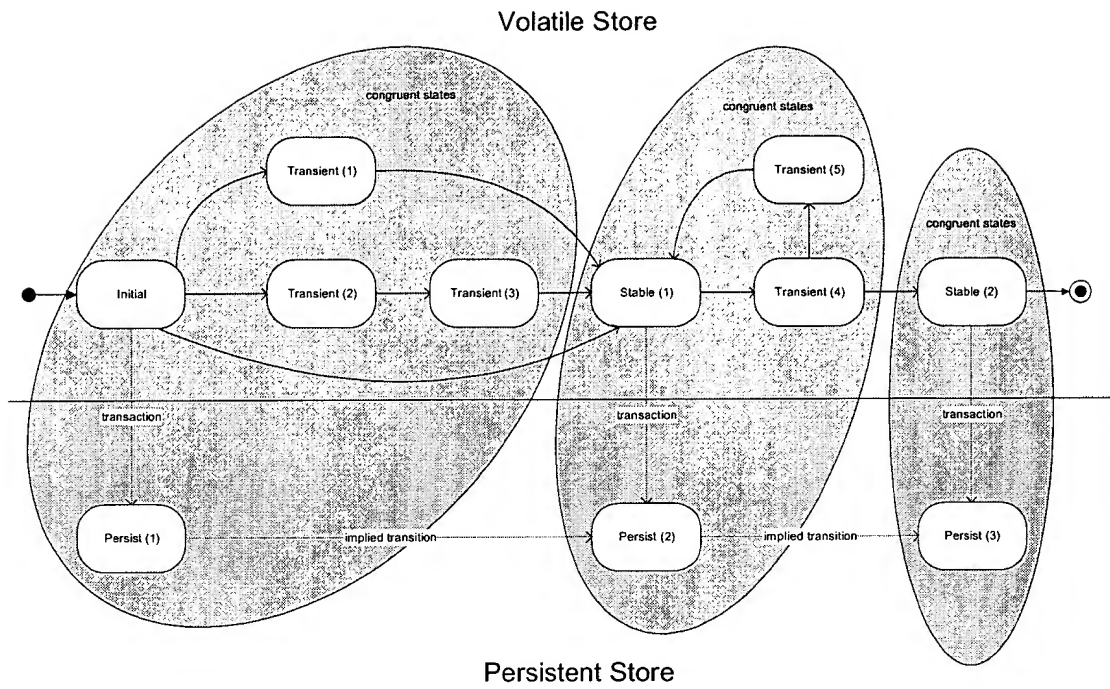
Figure 32H

Call Detail Record (CDR)

Definition	Describes call and feature usage characteristics relevant to call and/or feature billing, and facility usage accounting.
Native Format	Log of ASCII based markup.
Source/Authority	Call and Feature Processing; call and feature processing generates CDRs according to call and/or feature policy.
Value Initiation Frequency (High)	CDRs are generated per call and per feature. There may be multiple CDRs associated with a single call or feature.
Value Change Frequency (Static)	CDRs are static once generated.
Value Access Frequency (Low)	In general, CDRs are accessed as needed to support AMA or other billing interface data generation, and as needed to support facility usage accounting. AMA generation frequency is described elsewhere. It is anticipated that other billing formats and facility usage accounting data are generated no more often than daily.
Schema Change Frequency (Moderate)	New CDR schemas may be introduced with the introduction of new call types and call features. Existing CDR schemas may be modified to support billing or facility usage accounting changes.
Consumer(s)	Billing and Usage Accounting processes.
Consumer Format	ASCII based markup.
Replications and Sharing	CDR data need not be replicated or shared among TSPs.
Scope	System
Volume	Generally coincident with call and feature volumes.

Figure 32I

TOP SECRET



Persistent Store

Figure 33

FIG. 33

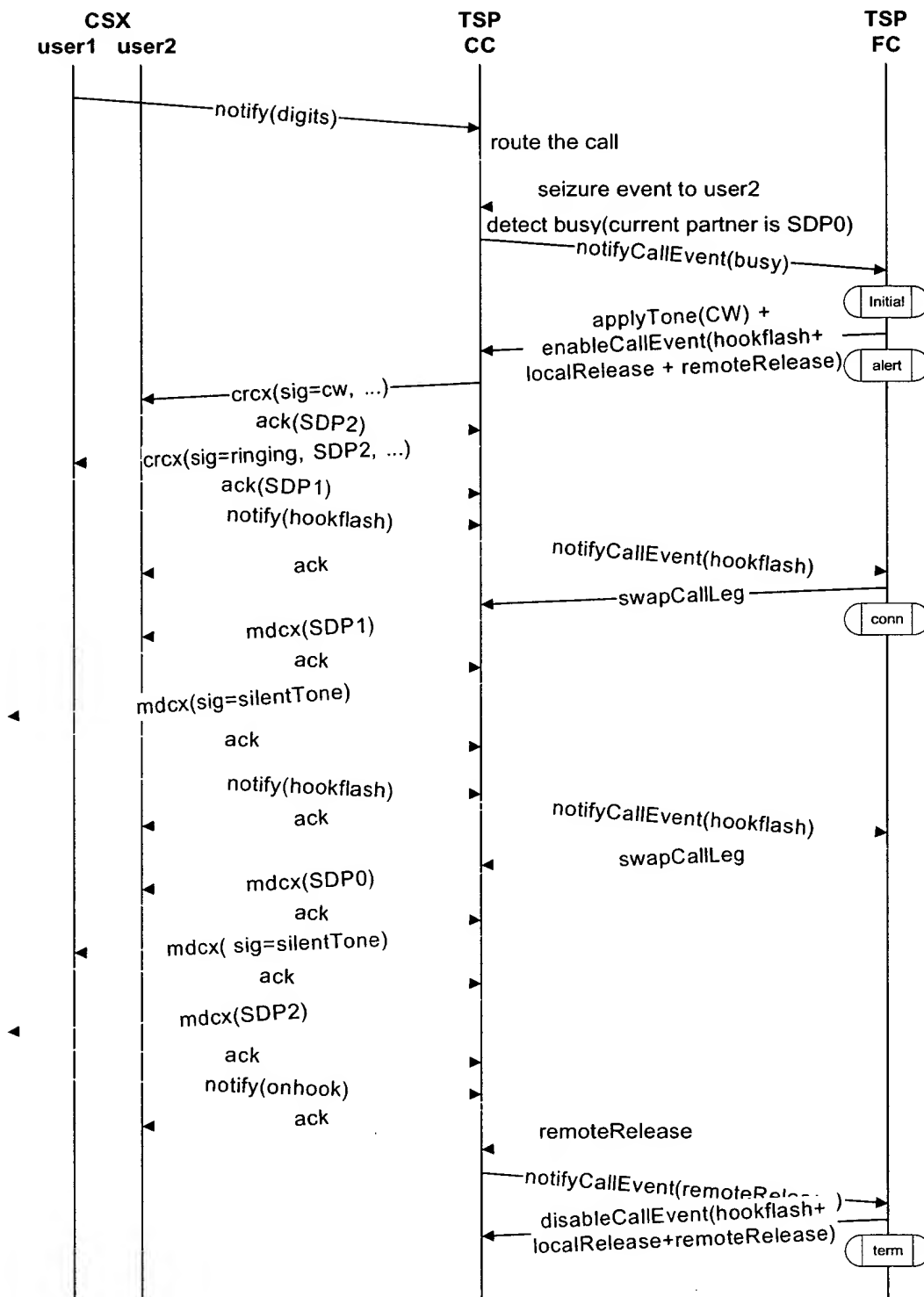
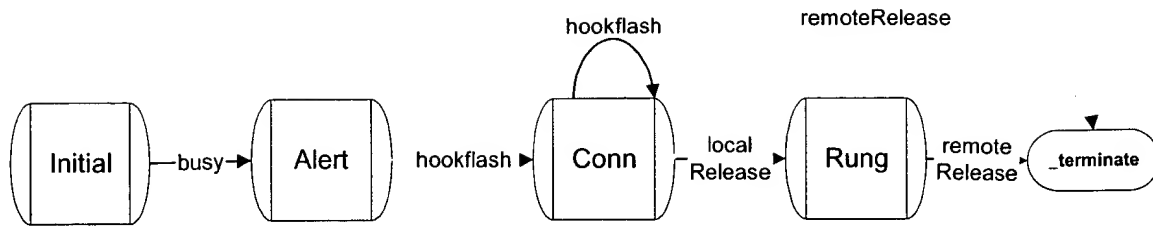


Figure 34



Call Waiting State Machine

Figure 35

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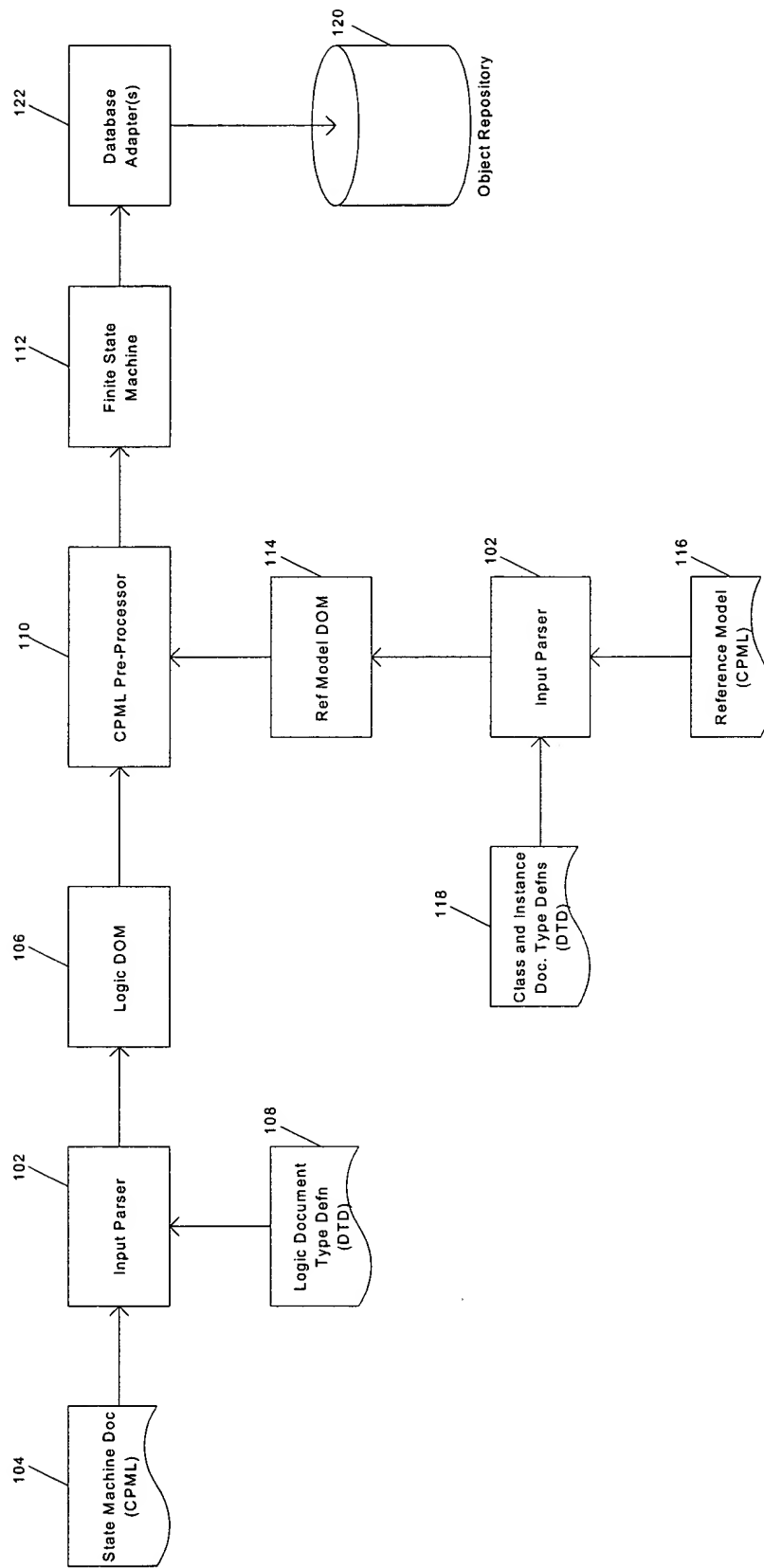


FIGURE 36

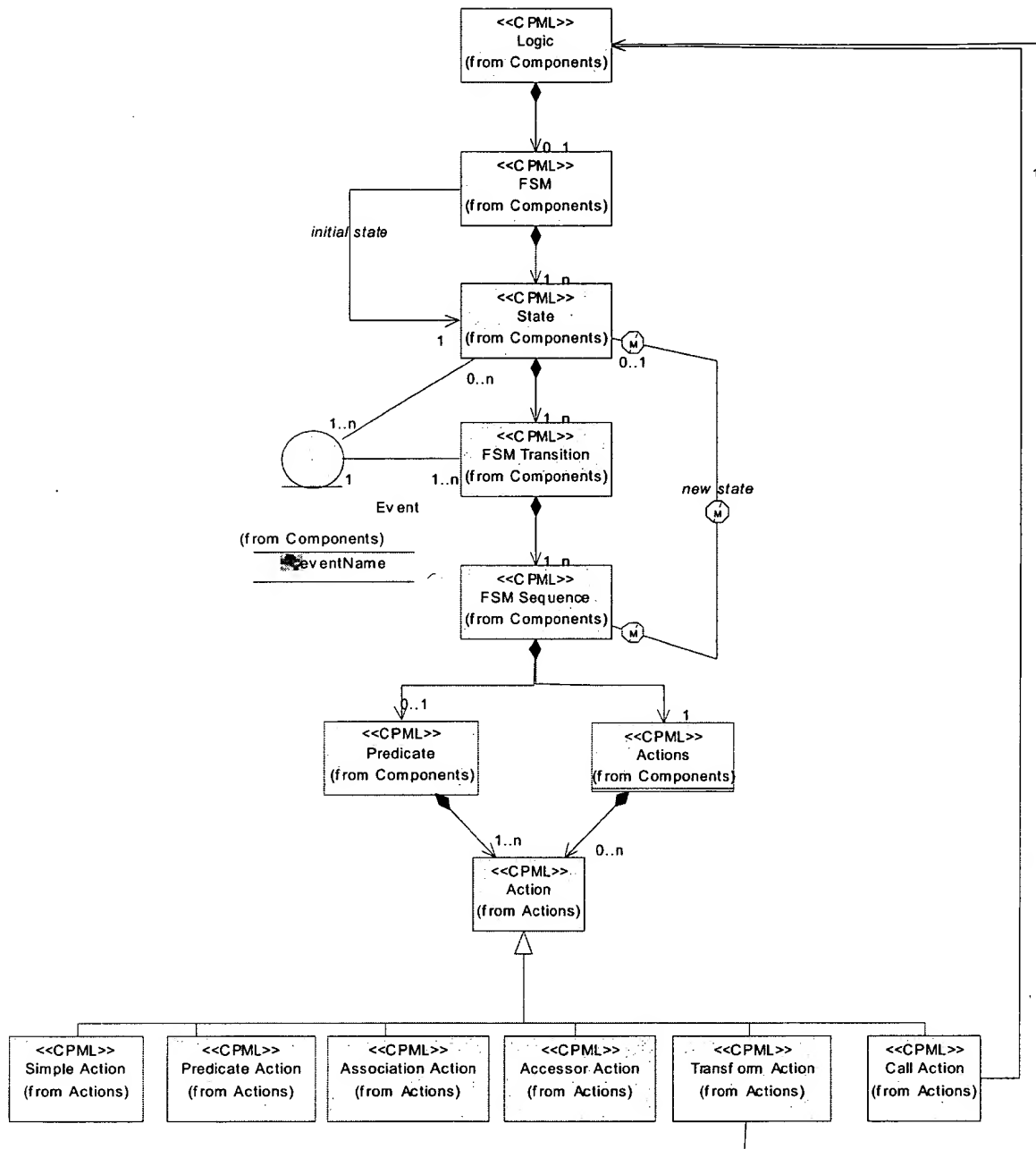


Figure 36A

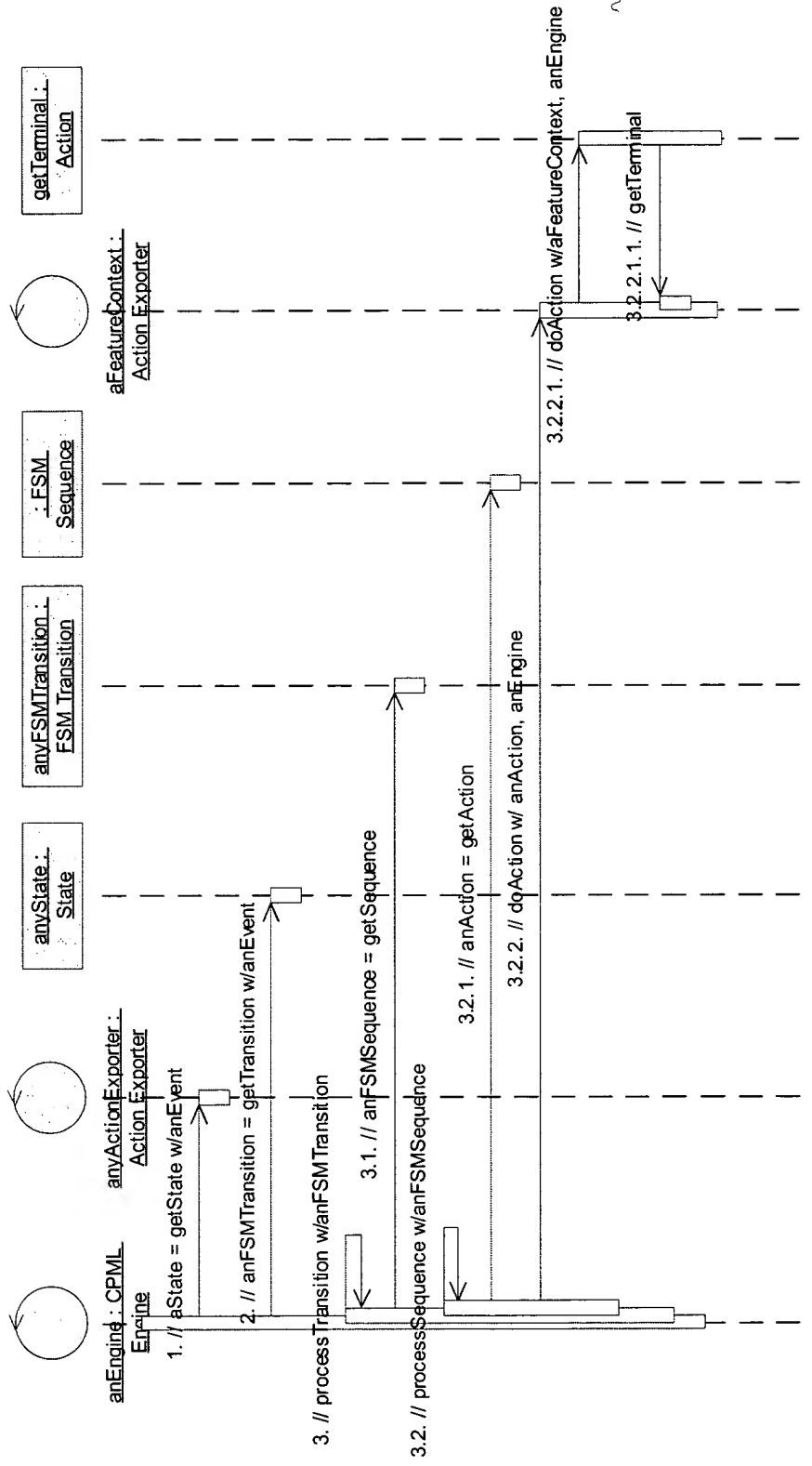


Figure 36B

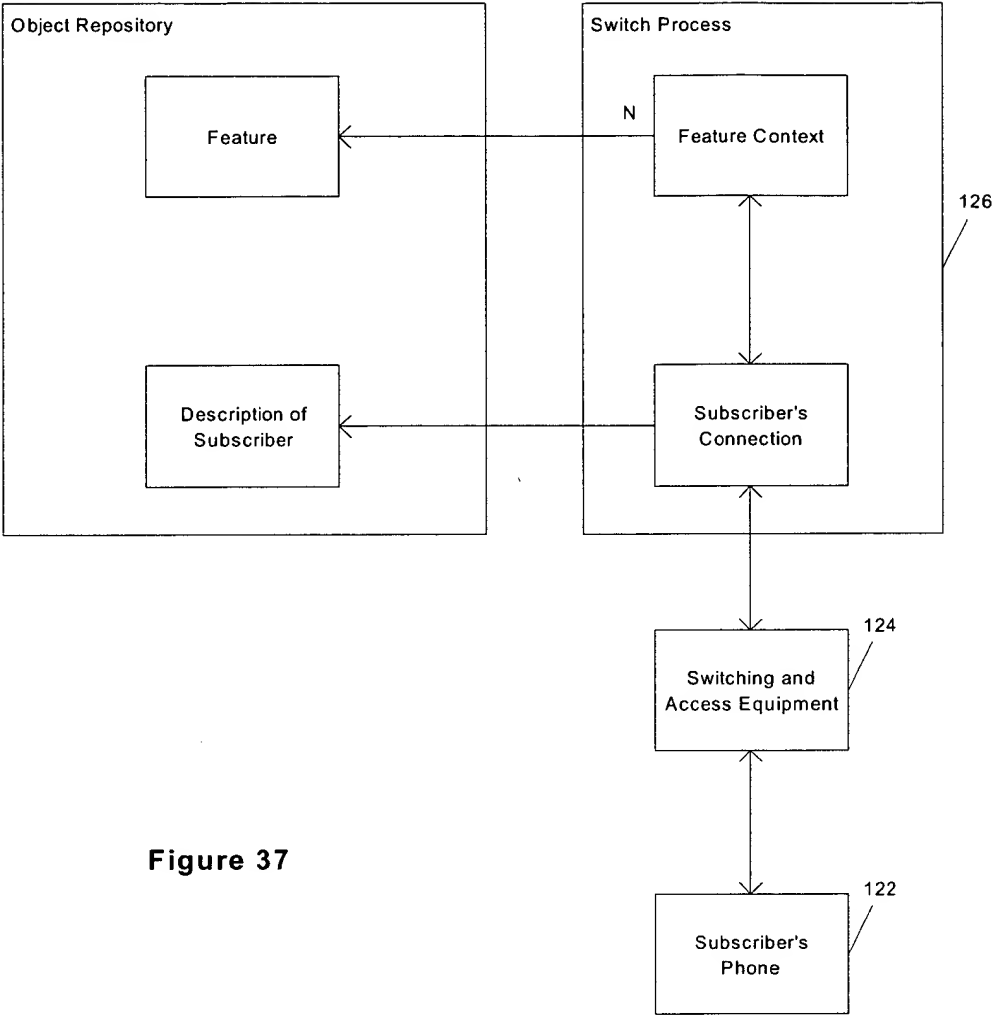


Figure 37

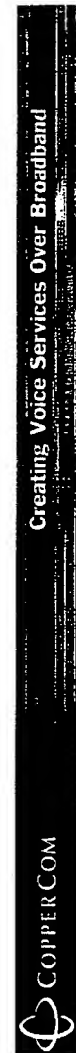
Example State Machine

```

<?xml version="1.0"?>
<!DOCTYPE LOGIC SYSTEM "fsm.dtd">
<LOGIC Name="CallAuthorizationSvc">
  <FSM InitState="START">
    <STATE Name="START">
      <TRANSITION Name="T1_1" Event="START">
        <FSMSEQUENCE NextState="CALL_AUTHORIZATION_SVC_END">
          <ACTIONS>
            <ACTION Name="postInternalEvent">
              <LITERAL Name="EventLiteral" Value="Authorized"/>
            </ACTION>
          </ACTIONS>
        </FSMSEQUENCE>
      </TRANSITION>
    </STATE>
    <END_STATE Name="CALL_AUTHORIZATION_SVC_END">
      </FSM>
    </LOGIC>
  </FSM InitState="START">
</LOGIC>

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Figure 38



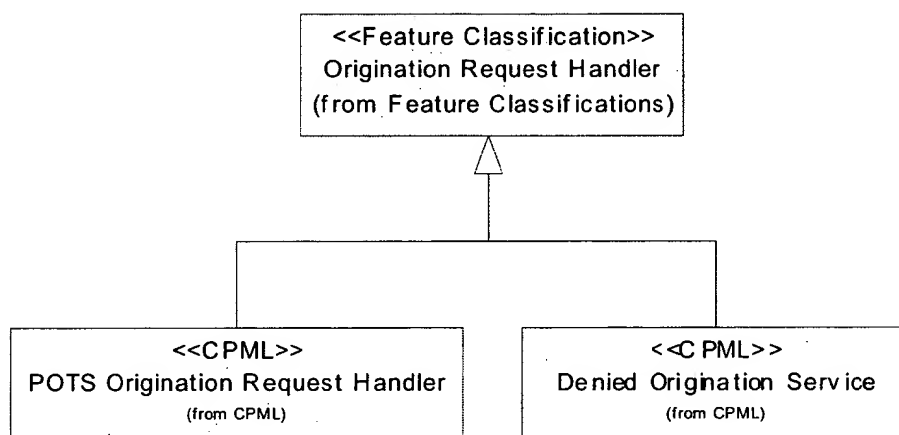


Figure 39

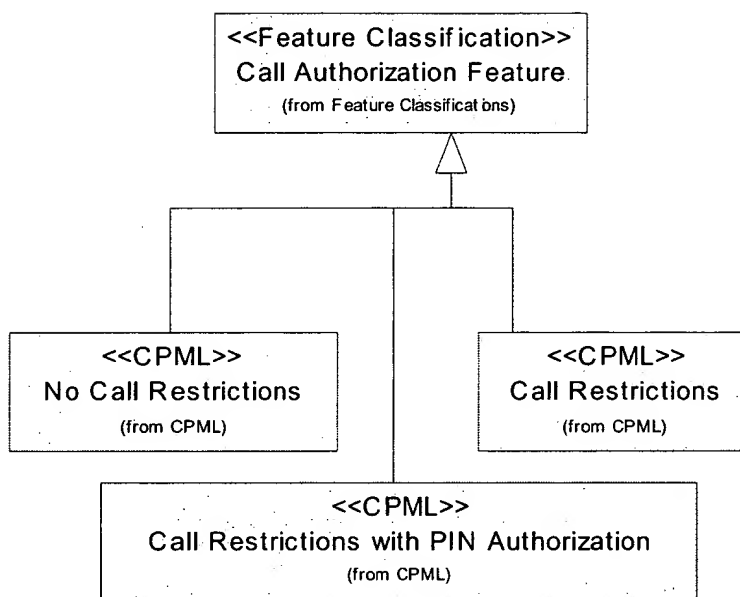


Figure 40

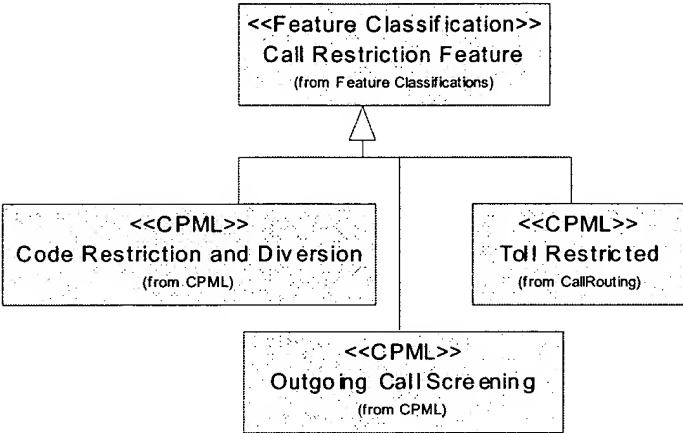


Figure 41

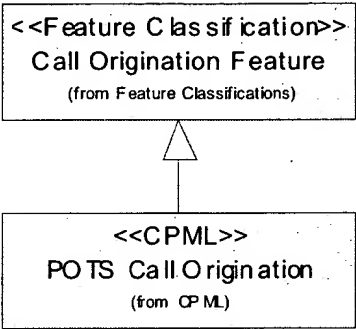


Figure 42

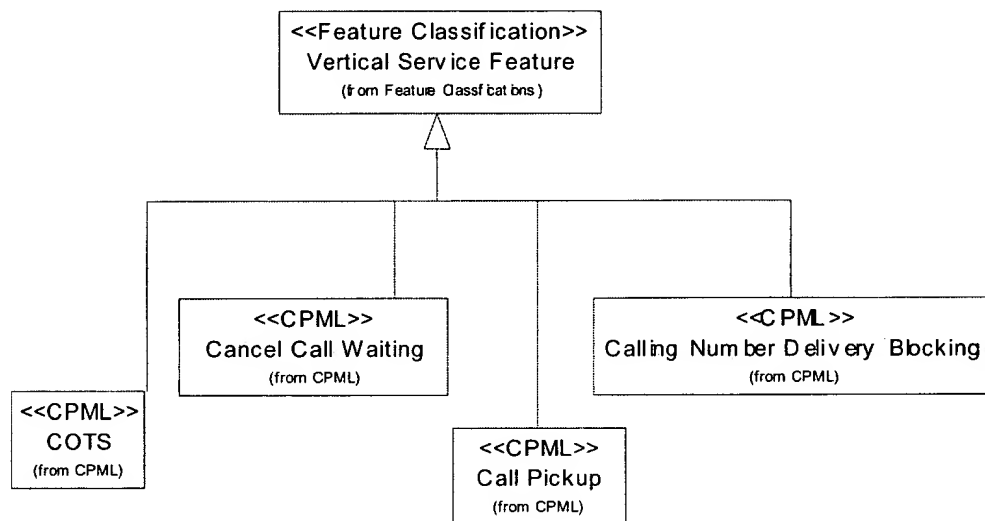


Figure 43

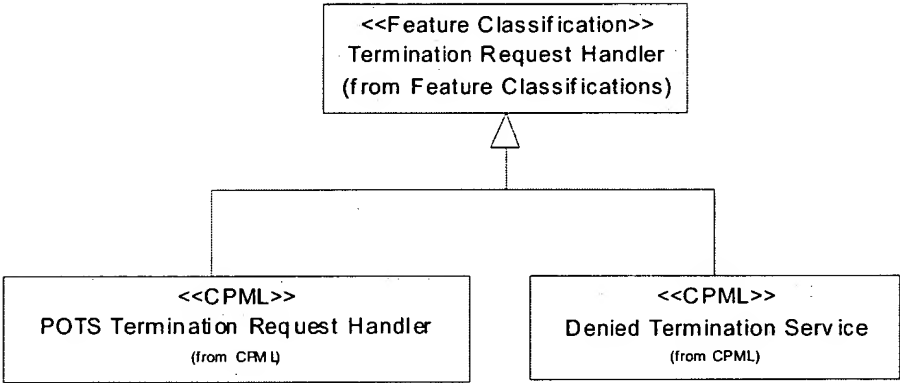


Figure 44

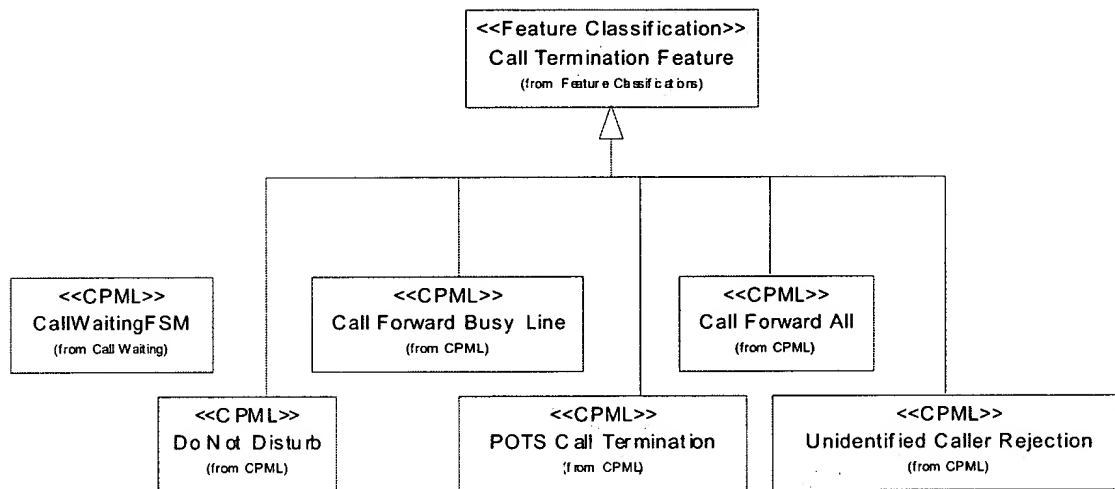


Figure 45

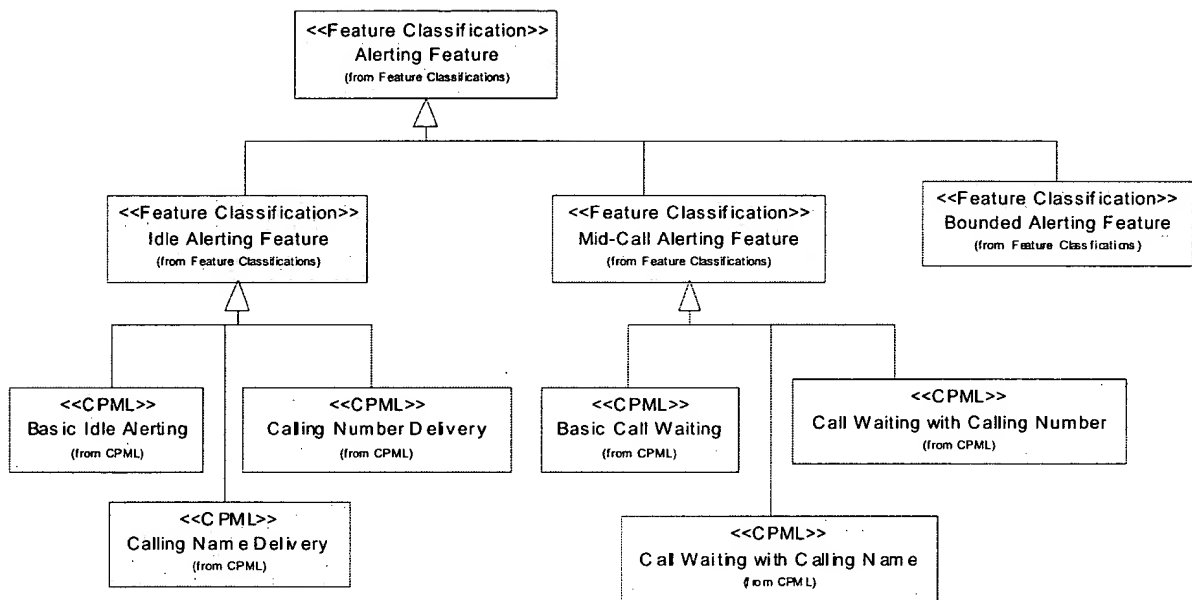


Figure 46

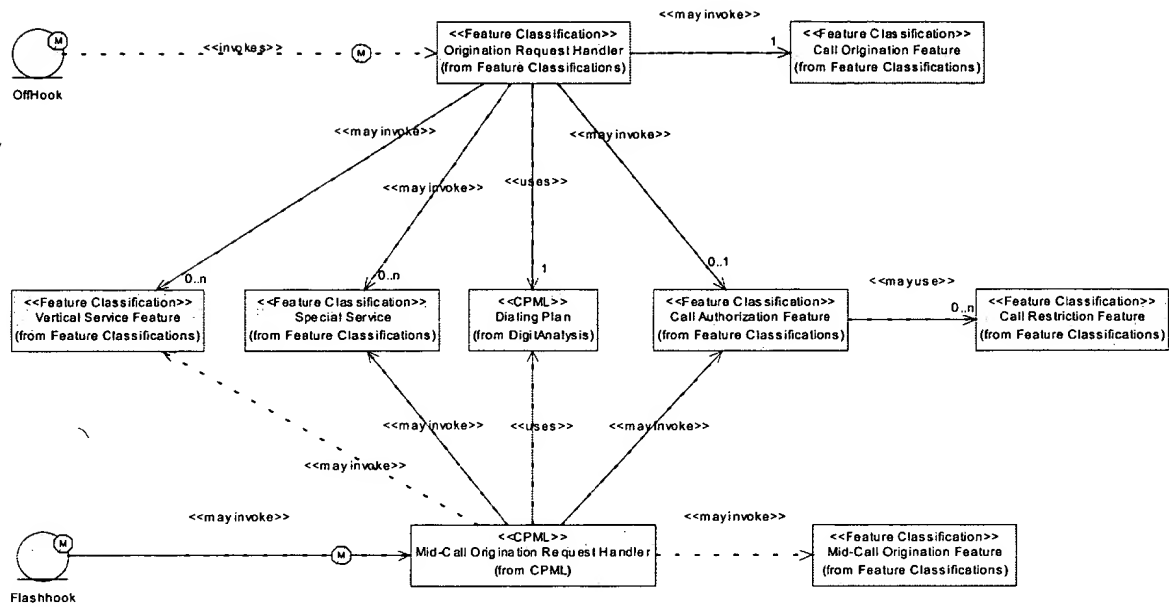


Figure 47

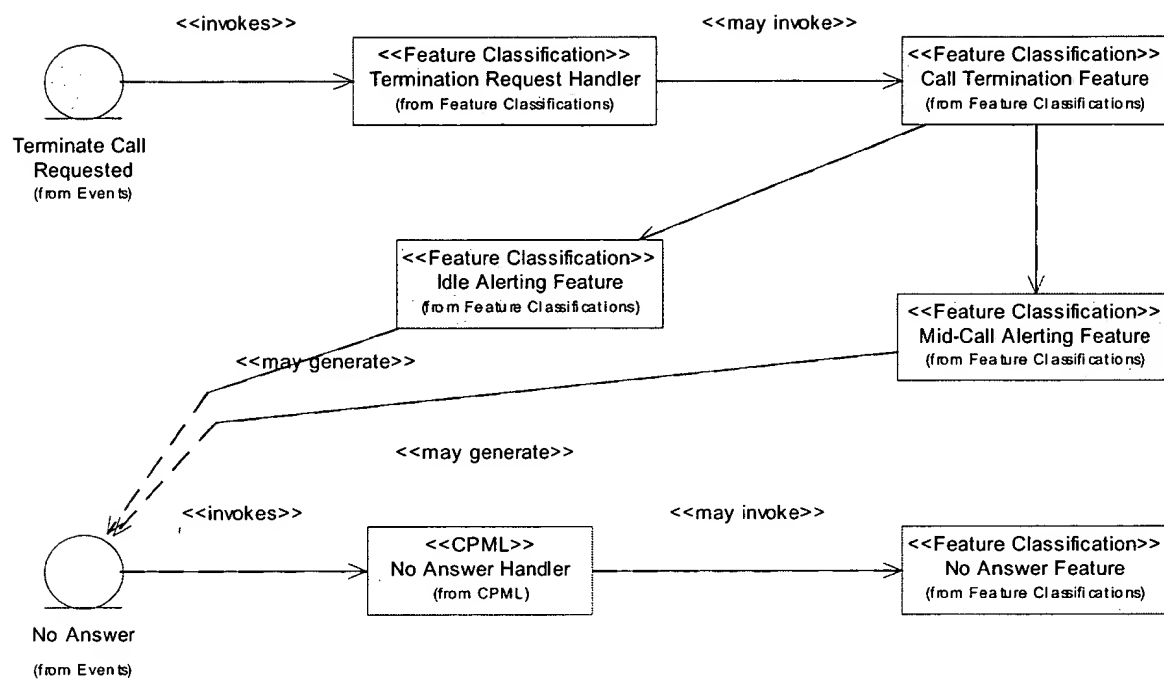


Figure 48

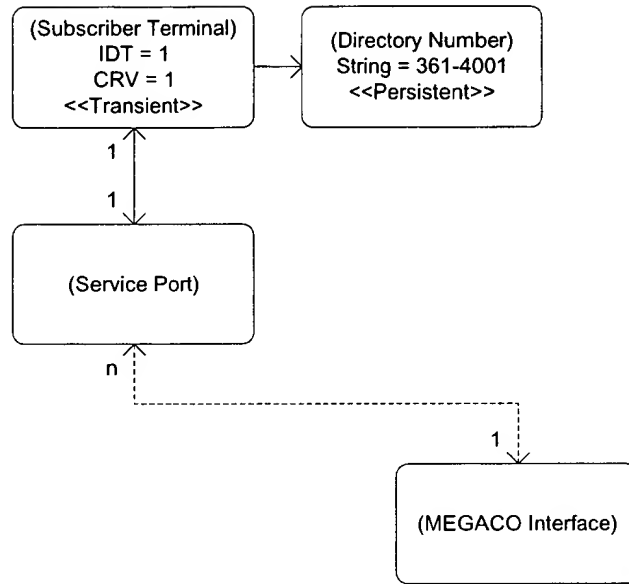


Figure 49A

FIG. 49A is a block diagram of a system architecture.

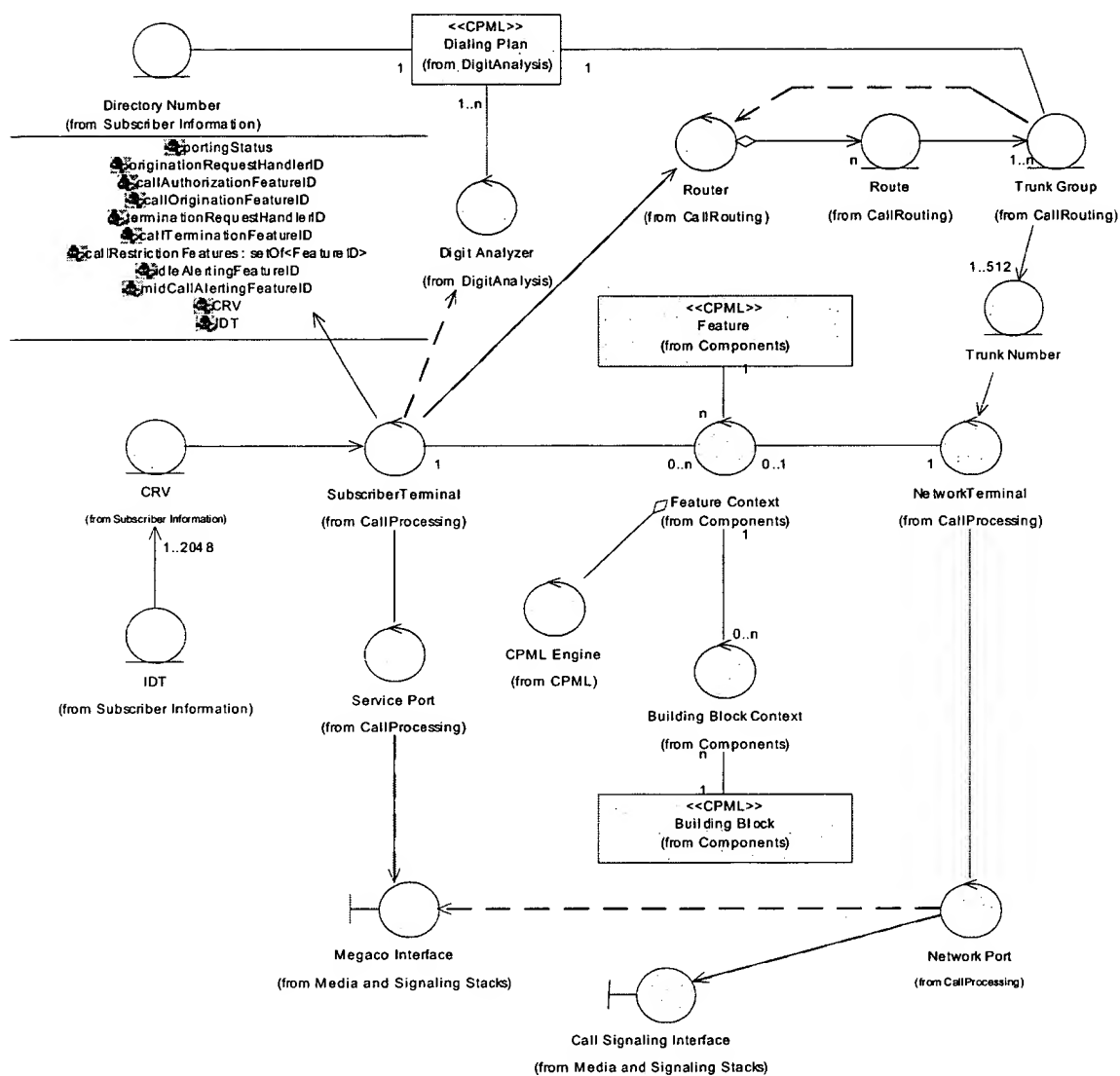


Figure 49B

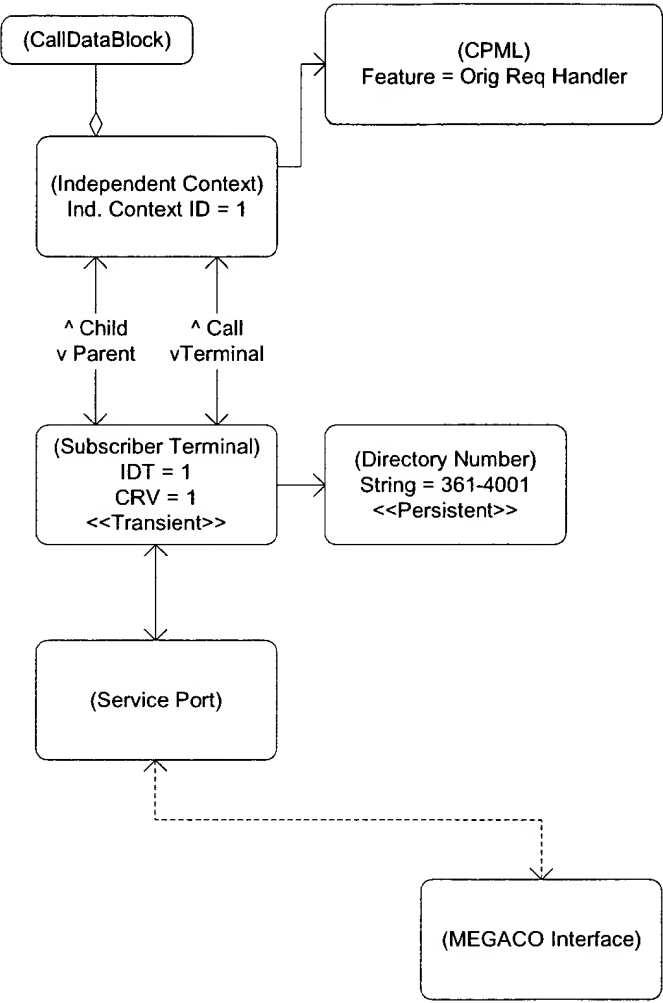


Figure 50

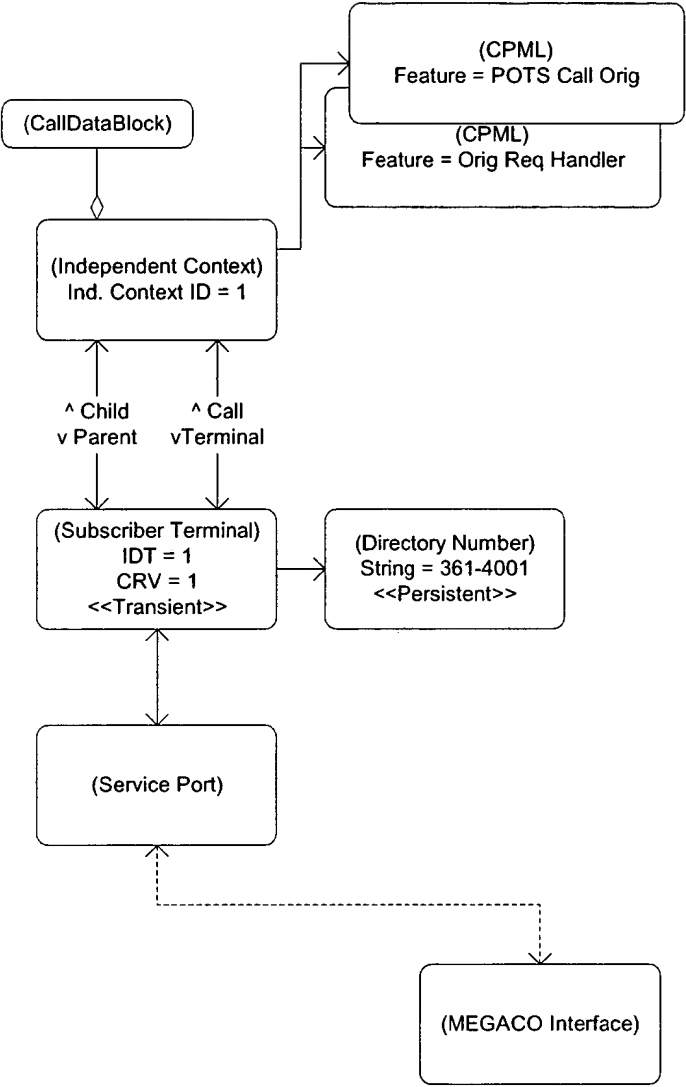


Figure 51

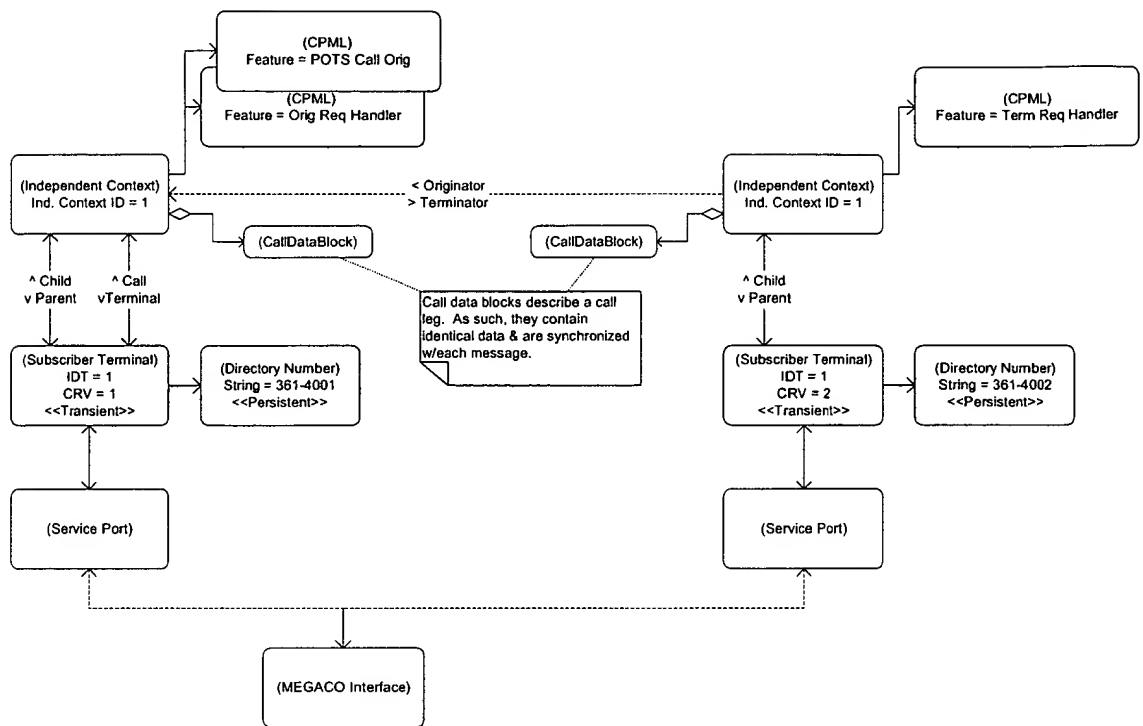


Figure 52

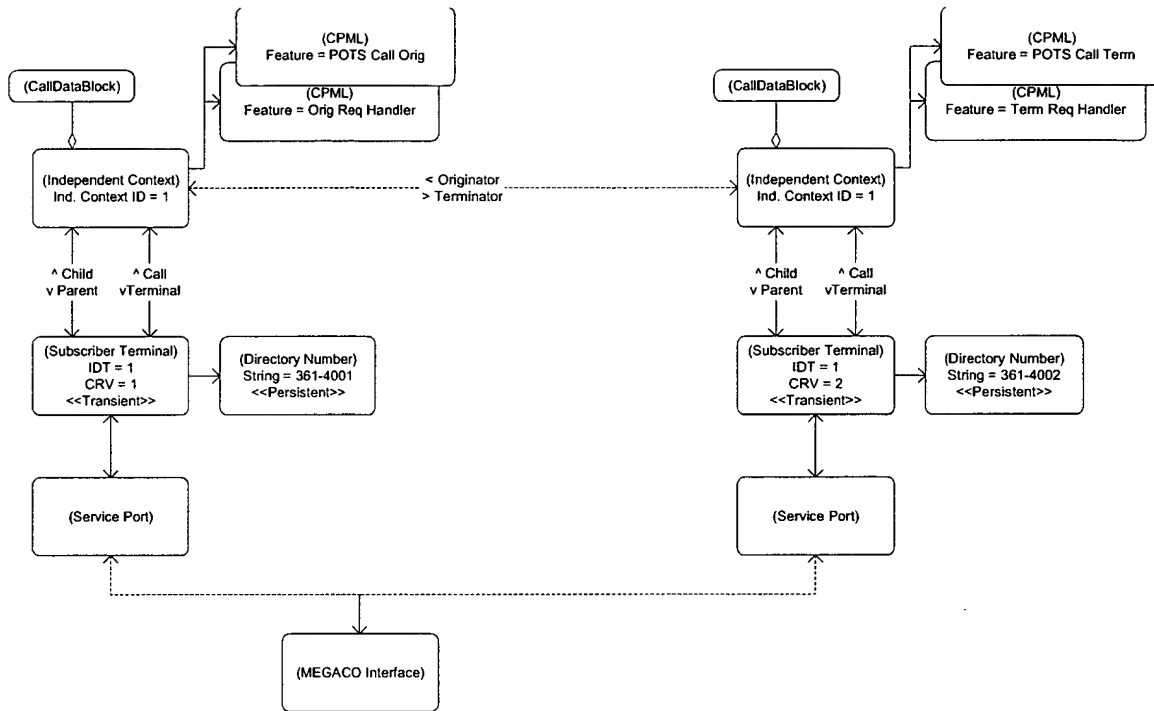


Figure 53

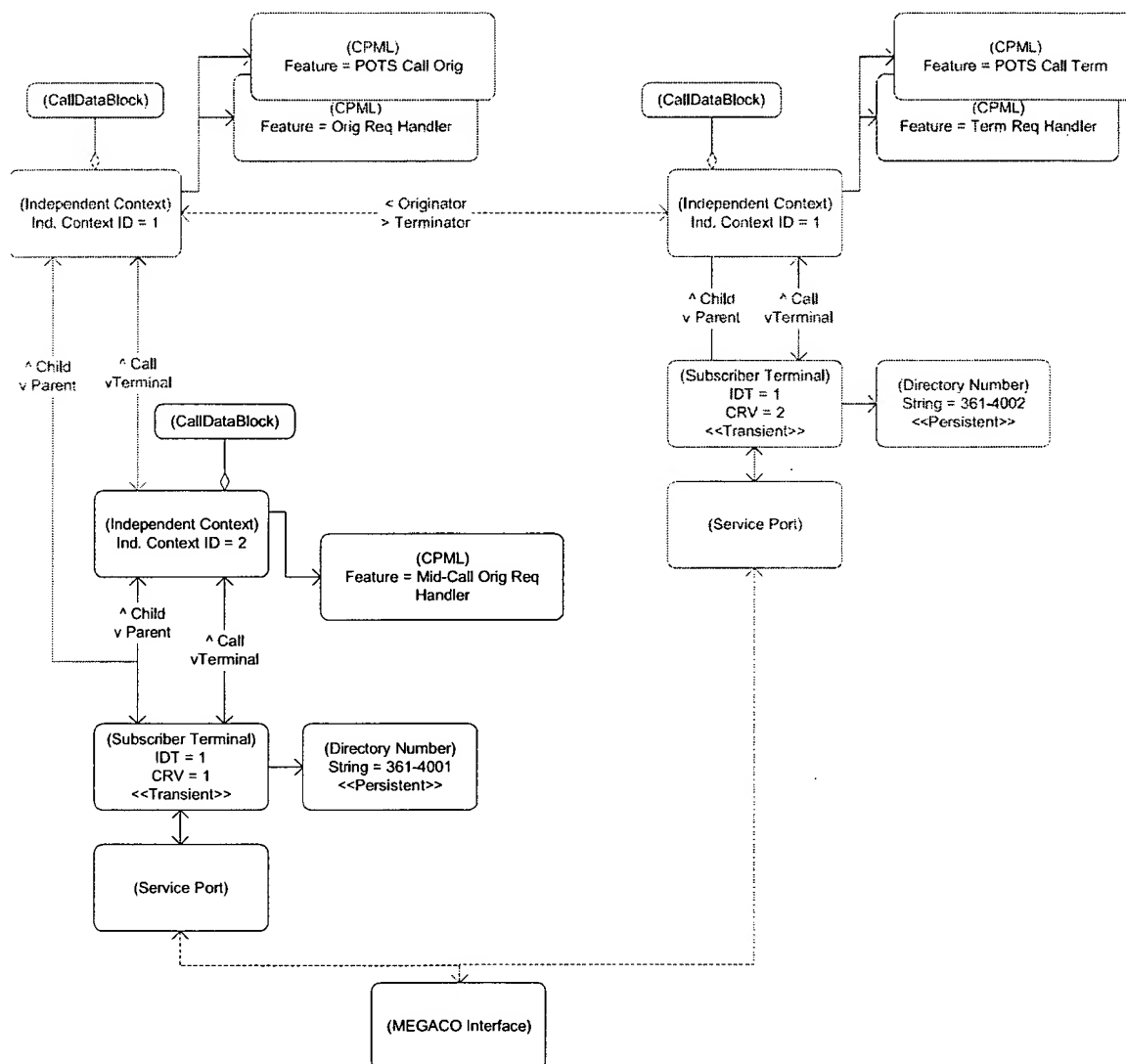


Figure 54

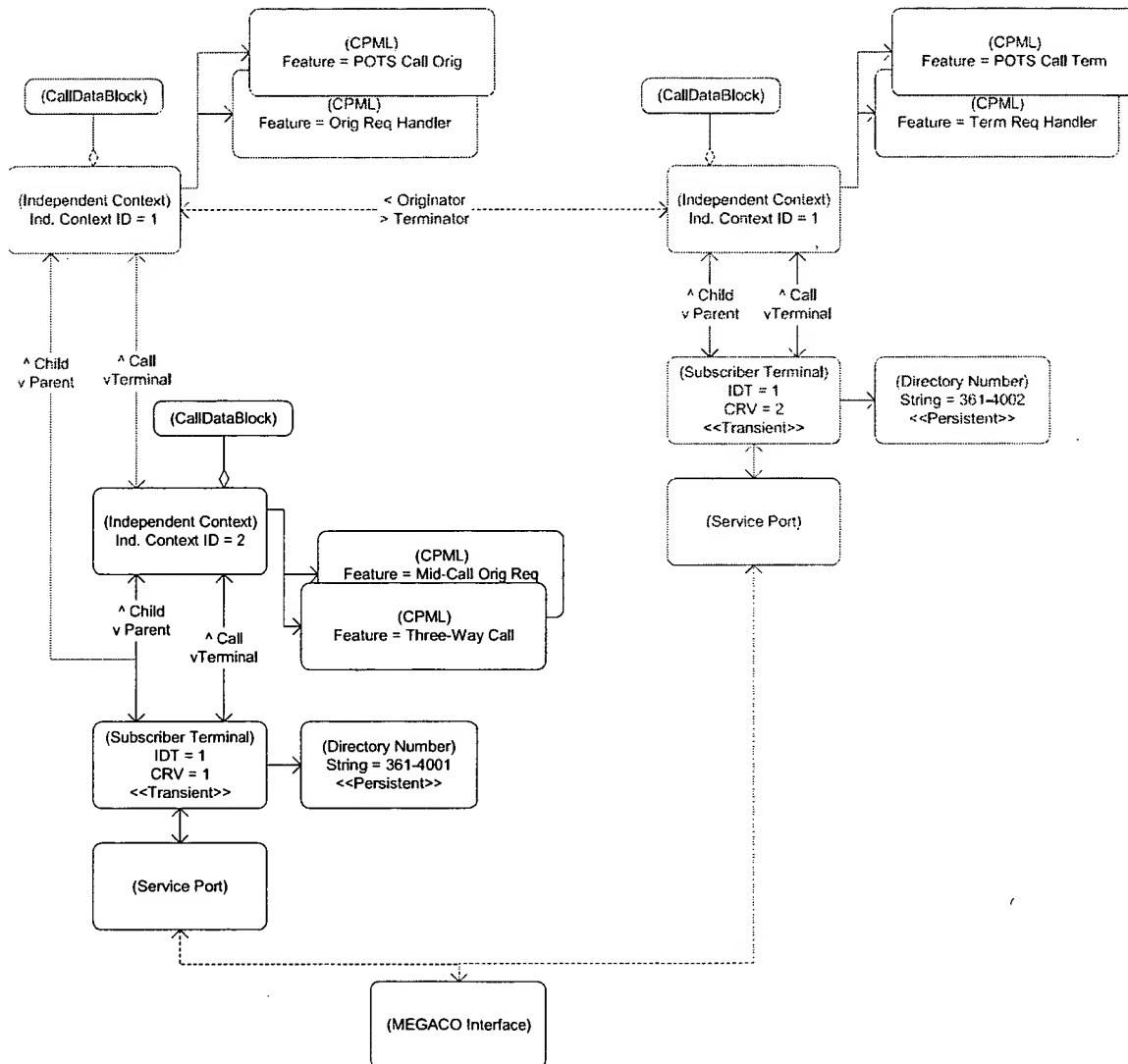


Figure 55

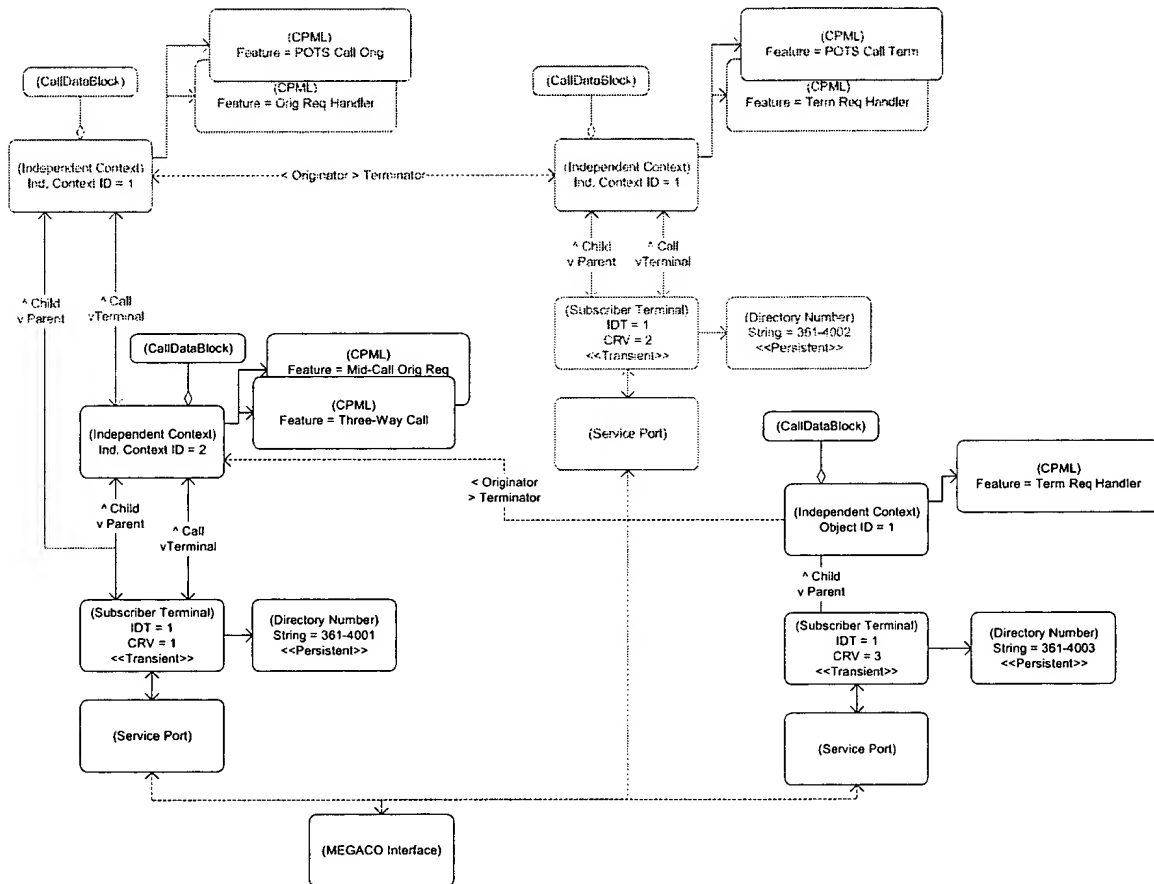


Figure 56

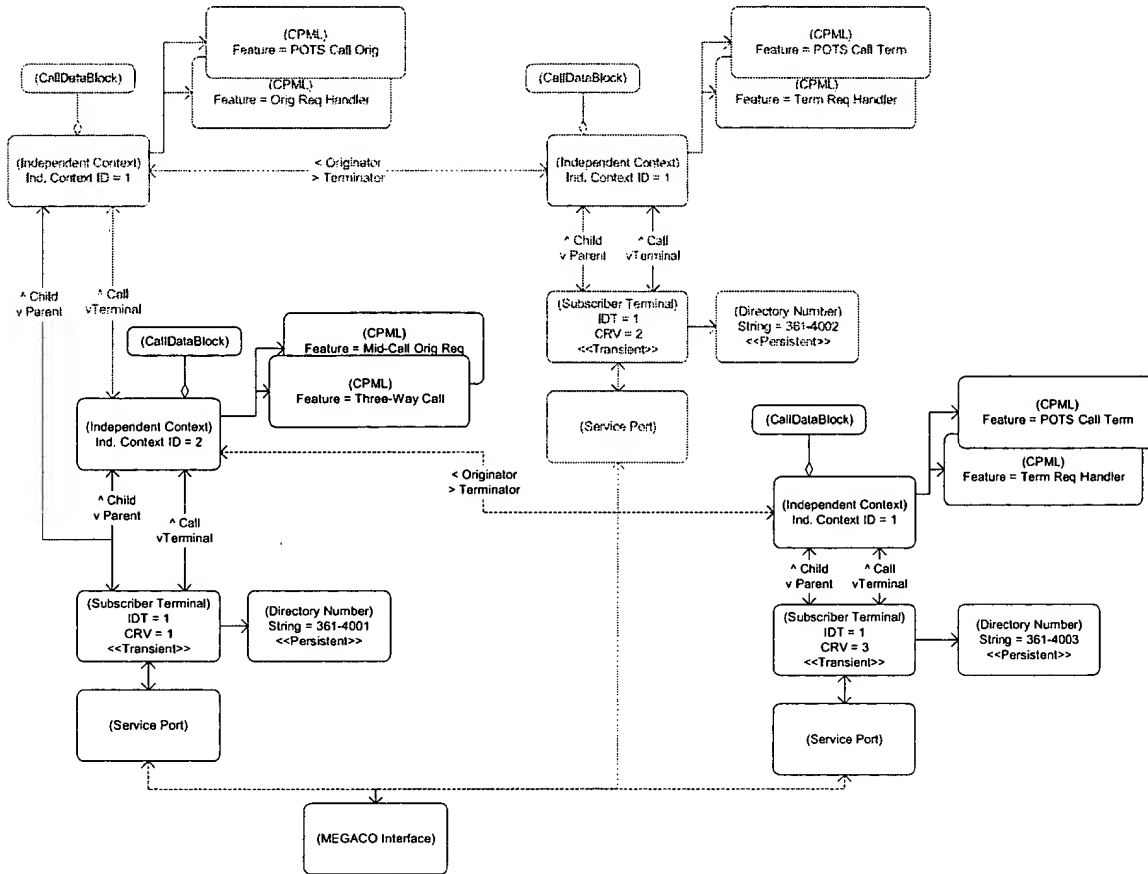


Figure 57

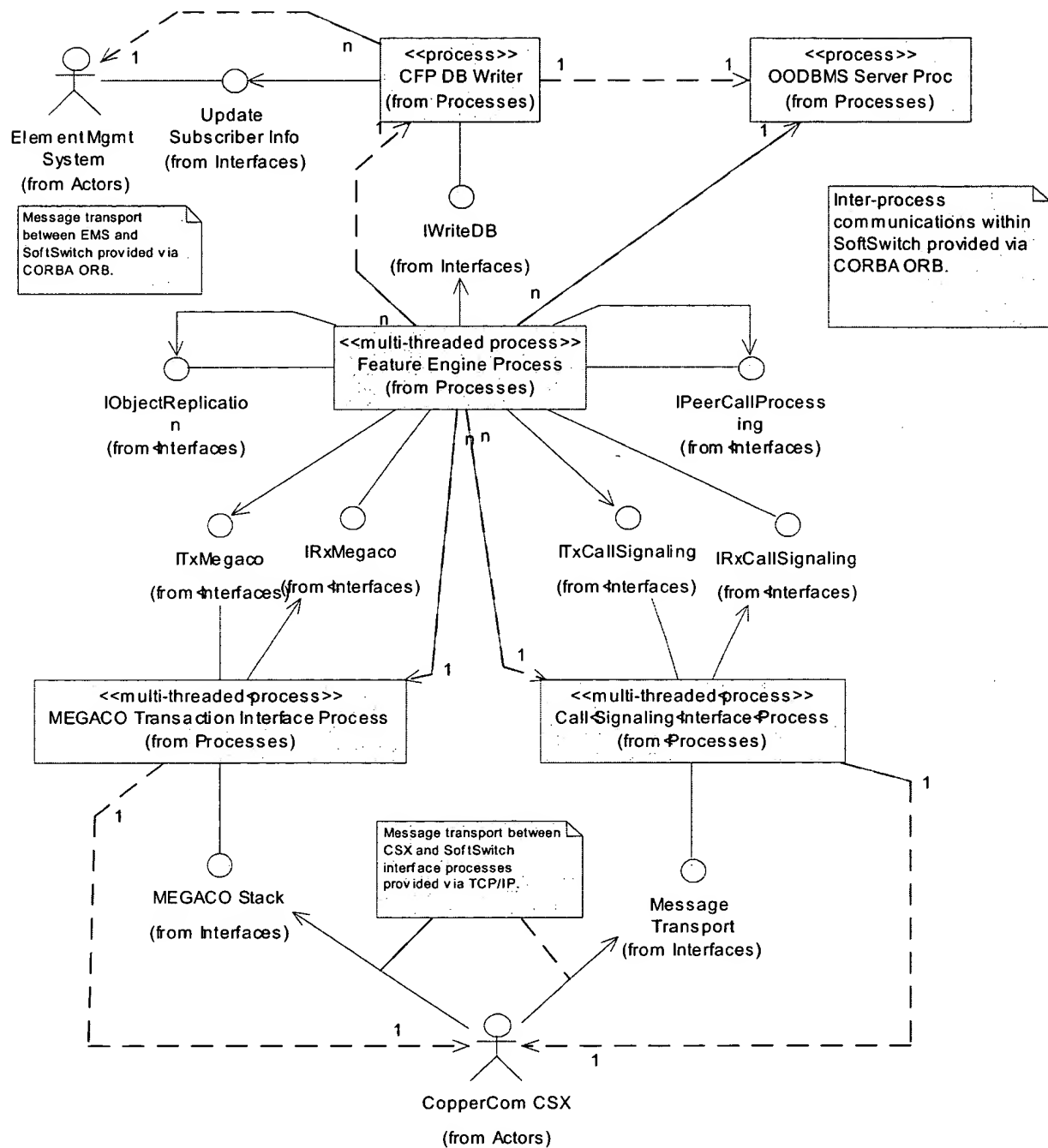


Figure 58